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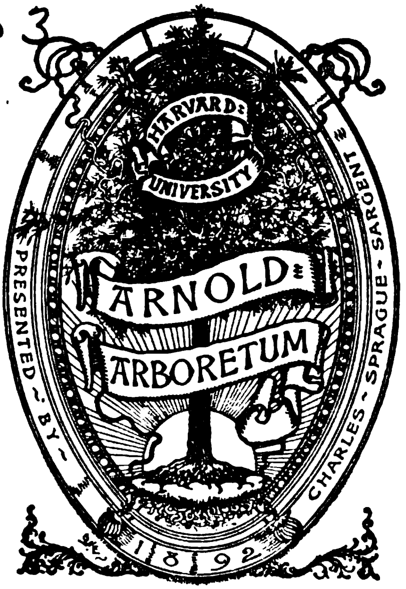

HARVARD UNIVERSITY
ARNOLD ARBORETUM
PRESENTED BY CHARLES SPRAGUE SARGENT
1892

Vol. II.　　　　　　　　No. 1

Proceedings
of
The Society of American Foresters.

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PROCEEDINGS
OF
THE SOCIETY OF AMERICAN FORESTERS

VOL. III. OCTOBER, 1908 NO. 1

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WASHINGTON, D. C.
PUBLISHED BY THE SOCIETY
1908

Yale Publishing Association
(Incorporated)
New Haven, Conn.

27585

Program of Meetings

Season of 1907-1908

November 14. Open Meeting. Paper by William L. Hall. The Necessity for the Appalachian Forests from the Standpoint of the Hardwood Timber Supply.

November 21. Open Meeting. Paper by Herbert A. Smith. Some Further Considerations Regarding the Tolerance and Intolerance of Trees.

December 12. Open Meeting. Paper by Edward E. Carter. The Silvicultural Results of Marking Timber in National Forests.

January 2. Executive Meeting.

January 9. Open Meeting. Papers by the Following Members:

M. B. Pratt—The Silvicultural and Commercial Importance of Red Fir.

W. W. Ashe—Forests and Domestic Water Supply.

S. L. Moore—Notes on Mapping Forest Lands.

February 8. Executive Meeting.

February 14. Open Meeting. Paper by M. O. Leighton. Studies of the Relation of Forest Cover to Stream Flow.

February 20. Open Meeting. Paper by Edward A. Braniff. Experience in Texas Forests.

March 5. Open Meeting. Paper by Henry Solon Graves. Condition of American Silviculture.

March 12. Open Meeting. Papers by the Following Members:

Frederick V. Coville—Experiments on Grazing Development in the National Forests.

Arthur T. Sampson—The Revegetation of Overgrazed Areas in the National Forests.

James T. Jardine—An Experimental Coyote-proof Sheep Pasture.

March 26. Executive Meeting.

April 2. Open Meeting. Papers by the Following Members:

Alfred Akerman—An Objective Point in the Taxation of Forest Lands.

Theodore S. Woolsey, Jr. (read by Herbert A. Smith)—Managing a National Forest from the Business Standpoint.

April 9. Open Meeting. Paper by Gifford Pinchot. Subject: Sir Dietrich Brandis.

April 16. Open Meeting. Papers by the Following Members:

Austin Cary—Influence of Lumbering upon Forestry.

E. R. Hodson—Silvical Notes on the Lodgepole Pine.

April 20. Open Meeting. Paper by Hugh P. Baker. Some Forest Problems of the Middle West.

May 21. Executive Meeting.

July 24. Executive Meeting.

PROCEEDINGS

OF

THE SOCIETY OF AMERICAN FORESTERS

The publications of the Society are sent gratuitously to all members. Copies of the Proceedings may be obtained of the Secretary for 25 cents each number.

VOL. III OCTOBER, 1908 No. 1

ANNOUNCEMENT

The activities of the Society of American Foresters have been heretofore confined chiefly to the meetings held in Washington during the winter. The papers read and discussed before these meetings have been published in the Proceedings of the Society, which has been issued about once each year. It has been the feeling among many members that the papers presented before the Society do not represent in a fair way the scientific work really conducted by the profession. As a matter of fact there are a large number of men in the country practicing forestry and conducting original studies, the results of whose work have not been brought before the profession. It is one of the objects of the Society to stimulate active work in every phase of forestry and to promote the public discussion of the work being done and its results. It is in this way only that our knowledge and experience can be systematized and the science of forestry be properly developed.

In the belief that the Society would be more effective if there were a publication of broader scope than heretofore, a committee was appointed during the past winter to consider a change. As a result of its recommendation, an amendment to the constitution was adopted, providing for an enlarged editorial board of the Society's publication and extending its scope to include contributed articles as well as papers read before a meeting of the Society. The Proceedings will hereafter be more in the nature of a journal for the publication of original articles and discussions than merely a report of the meetings, though the papers read at open meetings at Washington or elsewhere will continue to be published. A number will be issued whenever there is sufficient material to warrant it. It is expected that at first there will be four numbers each year.

It will be the policy of the Editorial Board to secure original articles from men in all branches of forest work, presenting the results of systematic observation and research; articles describing the work which is being done, its principles, methods, and results; and articles discussing fundamental questions of the theory of forestry, of policy, and of education. All problems of forestry are to be discussed, and the board will welcome articles on any subject related to forestry which will contribute towards the development of the science and aid those engaged in its practice. It is the desire of the board that there may be a complete freedom of discussion, for it is only through free discussion that the truth is reached and permanent results secured.

It is confidently believed that with the coöperation of the members the broadened publication may be made a source of increased interest in the Society and an important factor in the establishment of the science of forestry on a firm foundation.

HENRY SOLON GRAVES.

SOME FURTHER CONSIDERATIONS REGARDING THE TOLERANCE AND INTOLERANCE OF TREES

HERBERT A. SMITH

Delivered before the Society November 21, 1907

A paper was read before the Society of American Foresters last year, entitled " A New Explanation of the Tolerance and Intolerance of Trees." This explanation was found not in the varying light requirements of different species but in the moisture requirements of all species. The author of this exceedingly suggestive and valuable paper seems at times to have pressed his argument so eagerly as to have been led into untenable forms of statement. This in itself is a matter of small consequence, because other parts of the same paper show that it was not the writer's intention to ignore the light requirements of trees in pleading for a due recognition of their moisture requirements. Practically, it is beyond question that tolerance has been badly overworked as an explanation of the silvical conditions observed in our American forests, and Mr. Zon's reminder that there are other factors which may be more important came in good time. It may seem, therefore, captious criticism to take up, as I frankly admit my purpose to do, certain parts of that paper, though Mr. Zon could easily show that they do not, when cited separately, fairly represent what he himself had in mind.

My reason for doing this is that, if my own experience is any guide, the final impression left by the paper is somewhat misleading. Conclusions are likely to be drawn which it could not have been intended to establish, and yet for which chapter and verse can be cited. It may be not unprofitable, therefore, to review the facts again. For the sake of getting effectively before us the actual issues, I am going to ignore those parts of Mr. Zon's paper which offset his more extreme statements. In reality I am setting up a straw antagonist to demolish—and must here and now make my apologies to my predecessor in this discussion for subjecting him to so base a use.

The former paper brought forward, in opposition to the idea that the suppression of seedling growth under a forest cover is the result of shade and that the increased rate of growth which follows thinning is due to the access of more light to the crowns, reasons for regarding both of these phenomena as referable to the consequences of root competition for water in the soil. "In closing," said the author, "I would suggest that we think for a moment of a tree as consisting of a long pole which at both of its ends dissolves into a mass of branches or crowns, of which one is buried in the ground and the other is above the ground, and that the one above the ground has practically an unlimited space to grow into, an unlimited supply of nourishment, and all the sun energy necessary for the decomposition and assimilation of the carbon of the air, while the one under ground, except in wet soils, has a limited supply of water indispensable to all the physiological functions of the tree, and is often hampered in its growth by the proximity of the underlying rock. Must we not admit, then, that in searching for causes of the many phenomena observed in the woods we have altogether 'looked up' too much and 'looked down' too little?"

If all the assumptions we are here asked to make are true, there is indeed nothing more to be said. If it is the fact that all forest trees have "practically an unlimited space to grow into," and "all the sun energy necessary for the decomposition and assimilation of the carbon of the air," there is, of course, no competition in the forest either for standing room or for light, and both survival and growth depend solely upon the ability of the root-systems to secure the necessary quantity of moisture. It is not to be supposed, however, that the author intended this to be taken as a description of actual conditions. Trees do have a limit to their height growth, and they do shade off their own lower branches. Practically, therefore, the crowns are, like the roots, limited on all sides—above and below as well as by their surrounding neighbors—in the space which they can occupy. The important question is: To what extent have effects of a deficient supply of soil moisture been ascribed to a deficient supply of light?

I can not attempt even to contribute towards an answer to this question, which can be settled only by careful scientific observations and experiments. The question itself is of such fundamental importance in silviculture that it deserves the attention of all foresters, and this Society is in my judgment under great obligations to Mr. Zon for having raised it. My present purpose is merely to define a little more closely, if possible, just what the problem is, in the hope that such a further consideration of it may perhaps help in some small degree towards attacking it most effectively.

I confess that I can not attach quite the weight to the facts presented in the former paper which seemed there to be given them. "A great number of biological, ecological, and silvicultural facts," it was said, "tend to show that trees are not endowed with *any* inherent capacity of withstanding different degrees of light, they are not born tolerant or intolerant, but each tree under certain conditions is capable of growing thriftily in the open as well as when shaded from the side or even from above. The trees adapt themselves to different light conditions by assuming a form characteristic of open or shaded situations. What actually does exist and is observed are two distinct forms of trees, one corresponding to trees growing in the full light, the other to trees growing in the shade; and any tree under certain conditions can assume either of these two forms."

It was, I presume, a mere inadvertence which led to a form of statement seeming to imply that it is light, not shade, which according to the tolerance theory—if that is really all we can call it—trees have varying capacities to endure. It is not the capacity of a tree to thrive in the *open*, but in the *forest*, that is in question. But what shall we say of the conclusion that because all trees grown in the open tend to assume a like form, therefore they are not born tolerant or intolerant? It is to moisture conditions rather than light conditions, apparently, that the paper ascribes the difference in form between trees grown in the forest, where the roots compete with each other for moisture, and those grown in the open, where they are relieved from such competition. If this likeness of form goes to show that all kinds of trees are inherently of equal tolerance, should not an elm in a meadow rear a crown like that of a sugar maple? And a gray birch in moist soil more resemble a beech? Do not considerations along this line warrant us in showing a certain degree of skepticism in the face of facts which "tend to show that trees are not endowed with any inherent capacity of withstanding different degrees of light" (i.e., of shade)?

Let us, however, look into these facts a little. Trees grown in the open, we were reminded, have spreading crowns, short internodes, and narrow, small, and upward-pointing leaves. These leaves have certain marked anatomical characteristics. They are thick, with strongly developed palisade tissue, upper and under surfaces alike, thick epidermis, and shiny and hairy surfaces, especially the under one. Trees grown in the shade "are usually tall and their internodes are elongated; their leaves are large, broad, and spread horizontally, and their upper and under surfaces are not alike; the leaves are thin, their palisade tissue is poorly developed or is entirely lacking, but instead the intercellular spaces greatly increase; the epidermis is thin, consisting of only one layer of cells, and contains chlorophyll; the cuticle is thin, the leaves are dull and only slightly tomentose, and often even entirely glabrous."

"It would be too hasty to infer," according to the former paper, "from the fact that these structural differences are found in trees grown under different light conditions, that light alone is responsible for them." So far at least as the height growth and length of the internodes are concerned, it seems to me, with all deference to the author, that it would be impossible to infer anything else. As for the size, shape, and position of the leaf, the accepted theory of leaf-mosaic as an effort to make the fullest use of the light and air without which the physiological functioning of the leaf must stop, would not seem in imminent danger of overthrow. The anatomical peculiarities of the leaf, however, must be discussed more carefully.

To understand what these variations in structure may mean, we must think of them in connection with the vital activities of the leaf.

The leaf we may call essentially a factory and distillery combined. The factory manufactures carbohydrates. Its raw materials are carbon dioxid and water; its waste product, oxygen; its power, light-waves. The distillery is operated by heat. It gathers by evaporation from soil-water the relatively minute quantities of mineral salts which the water holds in solution. The immense quantities of water-vapor which the leaf must distill off in order to gather any appreciable quantity of these salts is brought vividly home to us when we remember that the water is substantially the same as ordinary well-water. Nature achieves a task impossible to man when it concentrates for economic use the potash, phosphorus, and other elements present in the water in proportions of perhaps one part in ten thousand, or even less.

It is worth noting that while the distillery is pouring away such enormous quantities of water in order to gather the mineral salts which the tree needs, the factory is gathering from the air the carbon which forms a little over half the substance of the tree in quantities quite as incredibly minute, when compared with the volumes of air from which it is taken. Carbon dioxid forms only three or four parts in ten thousand of ordinary air—and every molecule of carbon dioxid contains, of course, only one atom of carbon to two of oxygen, or three-eighths of the total weight of the carbon dioxid molecule in carbon.

Now what is the meaning of the anatomical peculiarities which have been mentioned as characteristic of the leaves of trees growing in the shade, considered with reference to the functioning of the leaf? Do these peculiarities indicate that the tree is struggling against a deficiency of moisture, or a deficiency of light? Before answering this question, however, we must have clearly in mind how a deficiency of moisture affects a tree unfavorably. It is not to be feared that the tree will in any case be unable to secure the necessary quantity of H_2O for use in building up the carbohydrates which are the product of assimilation—the output of the factory. Only an insignificant part of the water supplied by the roots is needed for this purpose. On the one hand, the tree must supply itself with the needed quantities of nutrient salts, and to do this must provide for a tremendous evaporation activity. On the other hand, it must protect itself against the loss of water faster than it can be supplied. This we might call maintaining proper sanitary conditions for the factory hands in the numerous rooms in which the work goes on. The health of the protoplasmic contents of the cells and the activity of the chlorophyll which utilizes the light-energy and does the work involved in rending apart the atoms of the molecular structures H_2O (water) and CO_2 (carbon dioxid) and recombining them into $C_6H_{10}O_5$ (carbohydrates), requires that they be constantly bathed in a liquid in which the nutrient salts must not reach too high a degree of concentration. Hence the contrivances which we find for restricting evaporation—the thickened cuticle, waxy or scaly surface, thickened epidermis, furry or hairy guard which may conceivably lessen the circulation of the air close to the surface of the leaf, though generally explained as devices to prevent the plugging of the stomata by water or dust, and last, but far from least, the mechanism which automatically closes the stomata as the turgidity of the cells decreases.

We can now take up the specific differences between the leaves developed by trees in full light and in the shade. Those in the light were said, first, to have their upper and under surfaces alike. If this means that stomata are found on both surfaces, this is often characteristic of leaves which are spread vertically. If it means that the arrangement of palisade tissue and chlorophyll are alike for both surfaces, this also is what we should naturally expect when leaves assume a vertical position and consequently expose both surfaces equally to light and air. The adjustment is surely for the sake of the light, first of all.

Again, the palisade tissue of trees grown in the open is strongly developed, that of trees grown in the shade poorly developed or altogether lacking. Now the palisade tissue consists of elongated cells rich in chlorophyll, arranged at right angles to the leaf, and apparently designed to utilize the light to as great a distance as it can penetrate effectively. Is it surprising that in comparatively feeble light this form of structure should become less pronounced, or even disappear? On the other hand, is not the presence of chlorophyll in the epidermal cells of leaves grown in the shade similarly ascribable to the need of carrying on the assimilative process as near the surface as possible? The rooms of the factory are ill-lighted—and the workers, therefore, move near the windows. I can not see how these facts, any more than the position of the leaves, can be regarded as anything but evidence that the tree is trying to make the best of deficient light conditions. What can they have to do with the moisture supply?

The remaining adjustments mentioned would seem to indicate rather that the leaves in the open are obliged to protect themselves against too rapid evaporation than that those in the shade suffer from a deficient water-supply—thick epidermis, and shiny (i.e., waxy), hairy surfaces on the one hand, and on the other thin leaves, with thin epidermis, thin cuticle, dull and only slightly tomentose or even glabrous surfaces, and greatly increased intercellular spaces. The last fact means, of course, greatly increased evaporation surface, as well as greater facility for the assimilation of carbon dioxid.

" All experiments," said the author of last winter's paper, " have led to substantially similar results, namely, that whatever diminished the absorption of water from the soil, like an abundance of soluble salts in the soil, or accelerated the exit of water from the plant, like dryness of the air or intense light, occasioned the following deviations from normal structure." Deferring for a moment the statement of these deviations, it is necessary to point out that it follows from the above that the same deviations should tend to characterize both trees grown in the open and those grown in a forest, where the competition of the roots results in an over-dry soil. For in the latter case we have a cause operating to diminish the absorption of water, while in the former we have causes operating to accelerate the exit of water from the plant—viz., greater air-movement, more light, radiant heat from direct sunlight, and a warmer and relatively less humid atmosphere. Hence it would appear that *differences* of leaf structure argue the operation of some other cause than too little water in the soil.

But let us see what are the deviations due to these causes.

They were set forth as follows: (1) Reduction of leaf surface. (2) Diminution of intercellular spaces containing air. (3) Augmentation of the vessels. (4) Lengthening of the palisade cells. (5) Increase in the thickness and amount of cutin of the outer wall of the epidermis. (6) Sinking of the stomata. (7) Increased number of air-containing hairs. (8) Increased number of water-storing cells.

It will be seen at once that some of these peculiarities are among those mentioned as characteristic of trees grown in the open, while others are among those mentioned as characteristic of trees grown in the shade. In a word, the anatomical characteristics of the leaf have entirely failed to give any reliable evidence that suppressed trees are really suffering, not from a deprivation of light, but from being robbed of the soil moisture by the roots of other trees.

I believe we shall come nearer the heart of the matter if, instead of trying to draw a final conclusion from the presence or absence of this or that structural feature of the leaf, we think rather of the physiological activity which is going on within it. The output of our factory and distillery combined depends (1) on enough power, and (2) on enough raw material to run the plant to its full capacity.

The conditions which normally obtain under a fairly dense forest cover are of themselves a protection against over-rapid transpiration, and I believe that we may dismiss this from our consideration as needlessly complicating the problem we are now concerned with. We may also, I think, pass over as irrelevant the question of the supply of raw material carbon dioxid, obtained from the air. This leaves to be considered only the supply of light and the supply of nutrient soil-water.

There must be for both of these requirements of the plant a certain *optimum*, any falling off from which must be accompanied by a proportionate abatement of activity. With plenty of water and plenty of light, all the machinery of life is running at full speed, the factory hands are in condition for most energetic work, and the sap-currents circulate under a full head, bringing raw material and carrying away the concentrated salts and the built-up carbohydrates as fast as they are made ready. With a falling off in the supply either of water or of light, the work begins to grow languid. To a certain extent a deficiency in either requirement may, it seems reasonable to suppose, be made up for by an abundance of the other. For the unfavorable moisture supply conditions found where trees rob each other of water in a dense stand are not those which would be likely to lead to over-rapid evaporation, and in point of fact the characteristics of leaf-structure noted as typical of shaded foliage conspicuously fail to show the development of defenses against evaporation. The cells are *regularly* cut short of water—not by loss, but by poor supply. The sap-stream has, as it were, little head; the cells are presumably ill distended, the conducting vessels certainly ill developed, the surrounding atmospheric conditions comparatively unfavorable to evaporation, and in spite of the poor supply of water the need of the plant is perhaps more likely to be for enhanced than for lowered transpiration. If this is true, it might well be that either an access of water or a moderate access of light would stimulate leaf activity and, in consequence, growth of the tree. For either would stimulate transpiration, while more light would, in addition, furnish more utilizable power also.

Is not the assumption of something like the above more consistent with the facts as we know them than the assumption that we should practically replace the shade-tolerance theory with a drouth-tolerance theory? A moderate thinning benefits a crowded stand, but too heavy a thinning endangers it. The thinning relieves the competition of the roots for soil moisture, and at the same time brings the stimulus of more light and results in conditions which make evaporation more easy. A half-starved, feebly active organism, which has let down its guards against giving off water too fast—has let its safety-valves, so to speak, get out of order—all at once receives the call to leap into full functioning. In spite of the fact that there is probably more water available for it than before, the chances that it will die for lack of water are decidedly increased. And it is worth asking, too, whether the roots have not shared in the general let-down of activity during partial suppression, so that they can not at once get to work at full speed.

With the theory which I have tried to propose, the experiments of Fricke cited in Mr. Zon's paper seem to me entirely consistent. Those experiments established that *under soil, climatic, forest, and weather conditions similar to those of the experiments* (1) the presence of roots lowers the percentage of water in the soil, (2) the exclusion of the roots of an established stand with no change of light conditions may stimulate the young growth on the ground and start up new forms in the undergrowth, and (3) the exclusion of root competition without change of light conditions facilitates the establishment of seedling growth. They do not, to my mind, in the least justify the assertion that "putting all these facts together there follows as a logical necessity, the deduction that failures of natural reproduction or suppression and even death of reproduction that had come up under the cover of old trees on poor, dry soils *are not due in the least to lack of light* but to competition with the roots of mother trees, and to the resultant dryness of the upper layer of the soil." Still less do they justify the challenging of the whole theory of "light increment" as fundamentally fallacious. For it must be borne in mind that these experiments were made on dry soils, in the summer months, with a precipitation which, though described as normal for the given locality, amounted according to Fricke's table, to a total of 7.9 inches between June 1 and September 4, or an average of 2.5 inches a month. How, after all, do these experiments carry us further than the statements made by Mr. Zon earlier in his paper, that "it is a matter of common observation that trees within the same climatic region when grown in fresh or moist soils are more tolerant of shade than when grown on dry or poor soils"? In other words, do not these experiments also fall in with the idea rather than upset the idea that trees have certain light requirements which vary with different species, but that in individual cases unfavorable light conditions may up to a certan point be made up for by moisture conditions sufficiently good to turn the scale, and that the vigor of the organism depends on the aggregate of all conditions, not on any one exclusively?

In short, the only kind of experiments that would really establish the conclusions which last year's paper seemed to draw would be a series showing that, by supplying water enough, the *most intolerant* species can be kept alive and made to grow under dense shade *just as well as the most tolerant.*

If I may be permitted to stray for a moment into the tempting, but perhaps dangerous, field of ecological theory without being too strictly obliged to defend what I would advance only as broad and general speculation, it seems to me that there is ground for maintaining that intolerant trees are on the whole those best fitted to endure deprivation of moisture. Is not a thin-foliaged tree one which has adapted itself to meager conditions? Given an abundance of light, moisture, heat, and plant food, and full-foliaged trees ought to develop, just as heavy feeding and generally favorable conditions tend to breed heavy stock. Reduce the supply of any one of these necessities of plant life to a point below the needs of the organism at the summit of activity, and the plant will no longer need the same leaf area. It is like confining an athletic boy to desk work, where his lung capacity is bound in the course of time to become relatively impaired. Cold climates, poor soils, and desert regions are the homes of the narrow-leaved and sparsely-foliaged broad-leaf trees. Drouth-enduring vegetation is characterized by an excessively small green surface. "For each gram of tissue," says Mr. F. V. Coville (Smithsonian Report for 1903, p. 500, "Desert Plants as a Source of Drinking Water"), "the coffee plant, representing the ordinary tissue of a humid climate, has a green surface 599 times greater than that representing a gram of tissue in the cactus; or in physiological terms, the coffee plant, other factors being equal, is provided with the means for the transpiration of 600 times as much water as the cactus." Nor does even this ratio tell the whole story, for the protective devices against evaporation in thickened cuticle, cutinized cell-walls, and deep-sunk, carefully-guarded stomata, reduce the activity to the very lowest point. Now all these things are, of course, in favor of the plant only as they make it possible for the plant to live at all. It has perforce adjusted itself to starvation conditions. A similar adjustment naturally follows subjection to low summer temperatures or poor soils. In other words, pioneer, high-latitude, and xerophytic vegetation does not need and does not develop a great expanse of leaf surface. Survival is not a question of being able to keep a place in a crowded forest under deficient light conditions—of light they have more than they can use. Hence xerophytic and pioneer trees naturally become relatively intolerant. They can not succeed in association with the tolerant trees developed on rich, moist soils and in a warm climate—climax species—because, though they can endure deprivation along these lines better than the climax trees, they are not fitted to endure deprivation of light. Thus is explained the fact that intolerant trees are commonly found on poor and dry soils—a fact extremely inconvenient for the theory that what we have been taught to regard as intolerance is really inability to compete with other species for soil moisture, since, according to that theory, the first species to suffer should be those which require most moisture.

In conclusion, what are the practical deductions to be drawn from all this discussion for the benefit of our own practice of forestry? Certainly not, it seems to me, that light is a matter of comparatively little importance either in connection with the establishment of reproduction or in connection with securing the most rapid growth. On the other hand, neither should the importance of root competition for soil moisture, under conditions where moisture is likely to be deficient, be overlooked. By emphasizing this fact Mr. Zon's paper called into the field of our attention a matter to which we were in danger of giving altogether too little thought, and thereby rendered an important service. Certainly we must not "look down" too little. There is, for example, the highly important question—especially, perhaps, when the management of a mixed forest is in question—of the varying depths from which different species mainly draw their moisture supplies. As Strasburger says: "The agriculturist and forester must . . . take into consideration the mode of branching and growth of the roots of a plant just as much as the habit of growth of its aërial portions" ("Text-book of Botany," London, 1898, p. 181). Before we can hope to devise the best practice we must collect and digest, painstakingly and accurately, full silvical data. We must look both down and up. When we are through we must know not only where the roots of the various species seek their moisture and how completely they pump the water out of the soil in different densities of stand, but also how far below the optimum we may reduce the supply either of light or of water without producing conditions too unfavorable for the development of the growth we are seeking, and to what extent unfavorable conditions with respect to one of these requirements may be counterbalanced by favorable conditions with respect to the other.

[A reply to this paper by Mr. Zon will be published in a subsequent number of the Proceedings.—Ed.]

THE SILVICULTURAL RESULTS OF MARKING TIMBER ON THE NATIONAL FORESTS

EDWARD EDGECOMBE CARTER

Delivered before the Society December 12, 1907

When the National Forests were first placed under administration by the General Land Office, the disposal of the timber in such a way that the permanency of the forest would not be impaired was one of the first questions confronting the officers in charge. These officers were not trained foresters, but among them were one or two men who appreciated the importance of leaving each cutting area in the best possible condition. One of the first rules issued was that each living tree should be marked by a forest officer before its cutting would be allowed. Then directions for the marking were issued as each sale was made.

The first work was naturally very crude and the directions for marking, when followed, not uncommonly produced results directly opposite to what was expected and desired; and now there is frequently a tendency to laugh at the directions and at the men who issued them, and terms such as " senseless " and " foolish " are not uncommon. Rigid adherence to fixed diameter limits formed the basis of these directions in nearly all cases. For example, I know of the sale of dead cedar in the Northwest where the removal of all trees above twelve inches in diameter breast-high was required by the terms of the contract, without reference to the question of merchantable lumber in trees smaller than this diameter or the defects in larger trees. The same diameter limits were fixed for yellow pine in the Southwest and for lodgepole pine in the Northwest. Twelve inches was the favorite in all parts of the country.

The results of marking under these directions may readily be imagined. In yellow pine it was only by accident that a basis for a future crop was left. In lodgepole pine many over-mature trees remained, and the stands were frequently in worse shape after the cutting than before. If it had not been for the violation of instructions by many of the local officers, the results would have been much worse than they are. It is also fortunate that the sales under the General Land Office were neither numerous nor large.

It is easy now to laugh at these old rules and at the men who made them; nevertheless, they were the first steps in the right direction, and the men responsible for them frequently had to work in the face of determined opposition. All credit, then, to the men who made the beginning. Those who are now issuing marking rules would do well to hope that the same credit will be given to them when the results of their work appear in the light of the progress that will be made in the next ten or twenty years.

Real progress in marking first occurred after the transfer of the National Forests from the General Land Office to the Forest Service. Trained foresters were then available for the first time for the consideration of silvicultural problems, and the needs of each sale could be intelligently considered as it was taken up. The variation of diameter limits to accord with the character of the stand was the first step. The application of a rigid diameter limit, however, still remained and, in fact, still remains in the minds of many of the rangers and even a few of the supervisors.

I remember examining, soon after the transfer, a forest which had never previously been visited by a technical forester. The timber sales were in a deplorable condition, and yet the Supervisor was an intelligent, painstaking man, who had followed his instructions to the letter. He had made a number of sales in a mixed type of Engelmann spruce and white fir, and one or two in aspen thickets. In his work of marking he was following instructions blindly, without the faintest idea of the reasons why they were issued. His rangers were fairly intelligent and all anxious to do the right thing in handling their sales, but they did not understand the reasons for any of their instructions. I do not remember a more pleasurable three hours on any National Forest than I had with this Supervisor and two of his rangers, in a driving rainstorm on a high mountain slope, going over a tract of timber for which application had been made, and explaining to them what results were wanted from the marking and how they could best be accomplished. The men were eager for information, and needed only to be told the why of things in order to appreciate and apply intelligently the written instructions which they had received.

I think my experience in this case was typical of that of a great many forest assistants. I can conceive of no work more valuable and interesting for a forest officer than to mark timber with the rangers, instructing them and answering questions as the work progresses; and if the rangers hesitate to ask questions, explaining tactfully the reasons for taking or leaving individual trees. The increased number of technical men available for this kind of work is having an appreciable influence and the recent marking, while by no means perfect, everywhere shows the effect of their work.

We have now come to look on the diameter limit as an evil rather than a help. It is, however, considered to be a necessary evil in most localities, although only two days ago a letter was received from a Supervisor in Montana recommending that no diameter limit be named in the contracts for the sale of timber on his forest. The same proposal was made at the Supervisors' Meeting in Sacramento, but was rejected by the Supervisors at that meeting on the ground that a purchaser was entitled to know approximately what size of trees would be marked. At that time a clause was offered as a substitute for the wording customarily used in contracts, which read somewhat as follows:

"The right is reserved not to mark any thrifty, immature tree, or any tree needed, in the judgment of the forest officers, for seed or protection. As a rule, mature trees will be marked." Variations of the clause, such as the insertion of species, were proposed. The Montana Supervisor went even one step further, for he recommended that the clause be worded as follows:

"The minimum diameter limit to which living trees are to be cut will be governed by the conditions of the Forest, and only trees that can be spared with safety to the remaining stand will be marked for cutting."

I hope that the discussion which will follow this paper will take up the practicability of the use of such a clause in dealing with purchasers of National Forest timber. At present the customary clause in our contract is as follows:

"The approximate minimum diameter limit at a point 4½ feet above the ground to which living trees will be cut is — inches, but trees above this diameter may be left for seed or protection, and merchantable trees below this limit may be marked at the discretion of the forest officer."

I have dwelt at some length on the diameter limit because in the past it has been the governing feature in marking on National Forests. I hope I have made it clear that it is distinctly the policy of the Service to work away from a diameter limit just as fast as the men can be trained to appreciate its failings and to apply the remedies. We have, at least, broken away from the old idea that the same treatment will bring equally good results everywhere, when applied indiscriminately to all forests of the West. Marking rules based on forest types and regions have been issued and are being further revised as fast as increased information is obtained and the faults of the rules appear under actual practice. I do not mean that the same set of marking rules is sent out to all the forests which have, for example, lodgepole pine, for the stands differ greatly in composition, in size of mature trees, and in the dangers which threaten the future crop. As far as possible, definite marking instructions are sent out in each sale, but it has been found that many rules are applicable to more than one forest, and there are certain characteristics of each type which render the same treatment possible, with minor modifications, throughout its range.

To take up by regions the present systems and their results, as far as noted, I should like to call your attention first to the forests in the Northwest. Here in dense stands of Douglas fir and hemlock but one course is possible—everything that will make a merchantable saw log must be cut, except carefully selected seed trees. If the opening is so large that it will not seed up from adjoining timber, the marking then can be confined to the few trees which are to remain, rather than the trees which are to come out. It is not a simple problem, to go on a densely timbered river flat, perhaps a mile in width, as might occur between two creeks, and select the trees which properly may remain. There is always danger, of course, that the trees selected will be unable to withstand the winds after their neighbors are removed; there is a still greater chance that when the ground is burned over, as it must be if desirable reproduction is to be secured, the fire will creep through the duff and girdle the trees at the collar, or kill the roots. The latter difficulty can be met by the purely mechanical means of digging a trench around each tree selected as a seed tree. The former difficulty can only be met through the selection of wind-firm trees by the man marking the timber.

The idea of a diameter limit in this type of forest has been and must be completely abandoned, for good silvicultural results can only be secured by establishing a new stand of Douglas fir, even at a sacrifice of many hemlock and cedar seedlings which had already started under the mature trees.

A complication is met in this region in stands which have escaped fire for several centuries, so that the intolerant Douglas fir has disappeared. This complication offers an interesting ground for experiment. Undoubtedly the best silvicultural proposition would be to cut clear and plant with Douglas fir. This, however, is out of the question at present. It is fortunate that in the only case of this kind which has arisen there is an abundance of Douglas fir on a high ridge near the tract, and good seeding of the fir may be expected.

Will a clear cutting method, as suggested above, be successful as a silvicultural measure? The results so far obtained indicate that it will. The sales which have been made in this type are little more than experiments. I have seen an area of about ten acres where this method was strikingly successful. At the end of two years one-year-old Douglas fir seedlings were coming up in abundance all over the area. On another area where fire had killed every tree, and where the ground had been thoroughly stirred up by the logging of dead timber, the same results were obtained. However, in this, as in other regions, our work is still in the experimental stage.

In the Sierra region the treatment adopted is distinctly different. The marking so far done has been largely on diameter limits for each species. The diameter limits for yellow and sugar pine, the most valuable trees in the region, have uniformly been higher than for the Douglas and white firs and the cedar. The results, however, are not gratifying. The limits for the better species have been altogether too low, and those for the poorer species altogether too high. The ideal silvicultural results would be to eliminate the poorer species from the stand. The marking so far done has in most cases resulted either in a diminution of the proportion of the better species, or at the best, in the retention of only the same proportion as in the virgin forests. In this type, however, the results become apparent more quickly than where clear cutting must be undertaken, and it has been possible to see and to correct certain mistakes which have been made.

At the Supervisors' Meeting in Sacramento the Forester stated that the ideal cutting would be one which removed practically none of the sugar pine, very little of the yellow pine, most of the Douglas fir, and all the white fir and cedar. This ideal has to be accommodated to the demands of the purchasers, who would completely reverse the list if they could. However, the marking of the sugar pine will unquestionably be much lighter in the future than it has been in the past, and better reproduction will certainly follow. The real cause of the trouble in this region, however, is that the diameter limit idea is not applicable. What has brought good results has been the work of men who selected each tree for cutting or retention in accordance with its condition and its importance in the stand as a tree of a desirable or an undesirable species.

Something over a year ago it took two months' correspondence to determine a diameter limit for a yellow pine sale in the Southwest. When the diameter limit was finally decided upon, the forest assistant in charge of the sale had already marked the timber, and had in the process very wisely ignored completely any diameter limit at all, but had based the marking wholly on the condition of each individual tree when considered in relation with the density of the stand and the abundance or absence of reproduction. The mistake in this case was due largely to the ignoring of the presence on the ground of a technical assistant, who from his training and experience could mark the timber without directions from the Washington office far better than could an untrained man with volumes of directions.

In the pure yellow pine forests, whether they be in Arizona, New Mexico, Colorado, South Dakota, or Montana, the only way to secure good silvicultural results is by having the marking done, as it was in this case, under the direction of a trained man,—not necessarily, of course, a forest assistant, for some of the rangers have been trained by forest assistants until they are quite as capable of doing good marking as the forest assistants themselves.

In most of these forests, particularly in Arizona and New Mexico, the present stand represents the maximum growth possible under the soil and moisture conditions of the regions. Reproduction is exceedingly scarce and hard to secure, except after a series of wet years such as have occurred recently. That much of the marking in these yellow pine stands has been too heavy is now universally admitted. That we have been fortunate in having a series of wet years, during which seedlings could obtain a foothold, has largely offset this damage. However, the danger is too great to be run longer, and the marking is now being done with a view of leaving at least all the thrifty "black jack" to form the basis of another cutting within a relatively short time, or where these are absent sufficient yellow pine are left to guarantee the seeding up of the area to its maximum capacity. That this represents a sacrifice of the timber is undoubtedly true, for present market conditions forbid the return of the lumbermen for the scattered trees so left. The present system is comparable with the German "shelterwood" system, without the final cutting. Its results are, therefore, bad, in that there is a waste of timber, and in that the ground moisture and air space are partially taken up for many years by trees which could well be removed for the improvement of the future forest. This is better, however, than to have no forest at all.

It is perhaps in the Engelmann spruce and Douglas fir forests of the Rocky Mountains that the greatest improvement in marking is possible. Certainly the widest divergence in the methods and results can be found there. It might be thought that in these natural selection forests the diameter limit will work less harm than anywhere else. My experience has been, however, that a fixed diameter limit may leave a mixed stand of Engelman spruce, Douglas fir, lodgepole pine, and white fir in the worst possible shape; and, on the other hand, that in those cases where a diameter limit has been ignored and a trained forester has worked in with the one idea of improving the stand by taking out the trees which should come out, the very best results can easily be obtained.

We are now recognizing those principles in our timber sale contracts in which it is customary to state positively that every merchantable white fir tree will be marked for cutting. Here the question of seed trees is seldom raised. There is an abundance of thrifty trees which will show a distinct increase in growth if they are given additional light and soil moisture by the removal of their over-mature or weaker neighbors. Here also the marking can in practice be made to conform more nearly to silvicultural principles on account of the rapidly increasing scarcity of timber and the willingness of lumbermen to take what they can get and be satisfied with it.

In a word, the results of the marking in this region up to the present go to show that good work can be done although a great deal of poor work has been done. The remedy lies in the training of the rangers, who must do most of the marking in the numerous small sales in the region.

One other major type remains—the lodgepole forests of Montana and Wyoming. This type has had more study than any other, and I personally feel that we know less about it than any other. Only one thing is certain, that any form of selection cutting or thinning on an exposed slope is sure to be disastrous on account of windfall. This has been clearly shown in the Allen sale in Montana where the clearing of strips 150 feet in width and the thinning of alternate strips 75 feet in width have been tried. There has not yet been time to show whether reproduction will be secured on the strips that are cleared. There has been time, however, to show that the thinning of the 75-feet strips results in the blowing down of most of the timber left. The same is true of an exposed slope in the Carbon Timber Company sale on the Medicine Bow, Wyo. The marking on this slope was not heavy, since the men who had it in charge took warning from the abundance of windfall already present. Even a relatively slight thinning, however, caused the windfall to increase alarmingly, and now the company is going over this slope and making practically a clean cut, in order to save and put on the market for use the timber which would otherwise be blown down.

There have been many experiments in marking lodgepole pine. In one sale in Montana an exceptional opportunity was offered for an experiment, because all classes of material are marketable. Here the supervisor was instructed to remove the scattered large lodgepole, which are undoubtedly the survivors of a former heavy windfall, and to thin out the dense stands of small trees, to obtain an approximate spaceing of vigorous trees fifteen feet apart.

Mr. Zon tells me that he doubts very much the success of this experiment, for the lodgepole on the high slopes, although only from four to six inches in diameter, will probably fail to respond to the opportunity for increased growth and will continue its present slow rate of increment indefinitely.

Somewhat the same system has been followed on the protected slopes in the Carbon Timber Company sale, as the result of an application of a rigid diameter, which, incidentally, worked better here than in any other place that I know of. I consider, however, that the proper system of marking to bring the best silvicultural results in this type is yet an open question, which can only be determined as results appear from the cutting now going on.

The results of the past marking on the National Forests are, then, unsatisfactory but improving. The local man is the key to the situation, but he must be trained. The responsibility for this training rests on the educated foresters of the Forest Service, some of whom work by correspondence, because it is their job; others work by talking with supervisors and rangers in the office and field, when they get the chance; and others do the most valuable work of all by getting into the timber to be marked with the local man and showing him how and why, in a way he never forgets.

PRESENT CONDITION OF AMERICAN SILVICULTURE

HENRY SOLON GRAVES

Delivered before the Society March 5, 1908

When a few of us met together eight years ago to organize this Society, forestry was just beginning to obtain some recognition in this country. Most of the foresters were engaged in promoting forestry rather than in practicing it. This was in part because the opportunities for the practice of forestry did not exist. There was no public land on which forestry was being applied, so that the opportunities for silviculture were practically confined to private lands. In order to introduce silviculture on private lands the Government offered to aid owners by giving advice how their forests should be handled. At one time this constituted the principal practical work of the Division of Forestry, and the applications for such assistance from private owners aggregated several million acres. As it turned out, this advice was often not followed and silviculture is practiced to-day on relatively few tracts as a direct result of the advice of the Government.* On the other hand, this work contributed enormously to the spread of interest and confidence in forestry and may be said to have had considerable influence in bringing about the assignment of the National Forests to the Department of Agriculture.

While eight years ago there was very little opportunity for the practice of silviculture, to-day the Forest Service alone has an enormous domain of public forests on which it not only has a chance but is required to practice it. At the same time the wave of interest in forestry has spread so thoroughly throughout the East that there will soon be very large areas of public and semi-public forests requiring silvicultural treatment, and already there is a good deal of sincere demand by private owners for real silviculture.

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* This statement applies particularly to the working plans, although I am informed that within the last two or three years the working plans for private owners have been followed in a much greater number of instances than formerly.

The time has now come, therefore, when we are called upon to put into practice the principles of silviculture, and our first inquiry may well be with regard to our preparation for it and what progress has been made in the American practice. Most of us have been engaged in laying the foundations for forestry and have not done much in the way of practicing it. I daresay that if I should make a canvass of this room and ask each person how much silviculture he had ever actually practiced, the amount would not be very impressive, except possibly by its smallness. I do not make such a suggestion in a critical sense, for we have been doing things which have had to be done to prepare for silviculture and have contributed far more to the advance of forestry in a broad sense then if we had all been planting trees in some corner of our respective native States or elsewhere. But it illustrates my first point in characterizing American silviculture; namely, that we have accomplished but very little so far in actual practice in the field.

In the application of silviculture in this country we are handicapped by a lack of knowledge of the life history and requirements of our forest trees under different conditions and by a lack of empirical knowledge of the best methods of handling our woodlands to accomplish the objects of silviculture. The practice of forestry has only just begun in this country, so that there are almost no results of actual forest management which can be used as a guide. We have only the results of European practice to draw upon. We ourselves have no background of experience as abroad. It is true that the fundamental principles of silviculture apply everywhere, but we have our peculiar types of forest, special conditions of market, of protection from fire, etc., and the methods applicable to present-day European conditions are not always applicable in this country.

This variance in practice is due not only to differences in the market conditions and the special policies of the forest-owners, but primarily to differences in the character, condition, and requirements of the forest. What is actually done in a forest depends on what it needs and what is practical. We are limited in our operations by poor markets for inferior trees, but we are also very much handicapped by a lack of knowledge of the behavior of the trees under different conditions of growth. A deficiency in our knowledge of the silvics of the tree makes it difficult to interpret the needs of the forest and to determine what the product will be under the changed conditions. This fact is brought very forcibly to my attention every time I make a marking for a reproduction or improvement cutting. I find, in doing this work, that there are an immense number of practical questions coming up about which we have little or no information. Those concern reproduction, tolerance, stimulated increment, recovery from suppression, resistance to fungus, and so on. In making thinnings there is scarcely a moment that one does not wish for empirical knowledge on some point. This lack of information involves often the whole scheme of silviculture. In view of these facts it is not surprising that our silviculture is sometimes characterized by recklessness and at other times by timidity. And it is also not surprising that advice given from the standpoint of theory and not of experience often does not inspire confidence.

The lack of experience is shown by the fact that a method of forestry actually used in this country is sometimes followed, primarily because it seems to be the only one that has been tried. The effort to follow experience rather than principle may in such a case result in wrong practice. An illustration is the tendency to use the selection system in conditions where it is entirely impractical. The cutting to a diameter limit in a forest of intolerant species is a common practice; and the use of the scattered seed method in the critical southwest just as it is applied with eastern white pine is another example of the same principle. Sometimes a species has been used for planting apparently because we know about that and not about others, or a method of planting or nursery practice has been followed without due consideration of changed requirements of site, climate, and species.

We know how to handle white pine and similar conifers, and so the former is planted on white pine soils, on chestnut soil, and many other sites where I feel certain that frequently some other species should be chosen. Another example is the use of catalpa. In some respects catalpa is the best advertised and most advocated tree for planting in the United States. The other day a man came into my office for information about tree planting on his estate in Palestine, near Jerusalem. I asked him what planting he had done already and he said that he had used catalpa. Catalpa is a very valuable tree for planting in certain localities and on certain sites. It has, however, been advocated by some persons for planting in places where it is utterly unsuitable. Our lack of knowledge of silviculture is further illustrated in the difficulty of obtaining positive information about the planting of chestnut, hickory, oaks, walnut, ash, sycamore, etc., on a commercial scale. And again it is illustrated by the differences of opinion as to the reproduction of hardwood lands in the middle States, and of the white pine of New England.

We are therefore in need of empirical knowledge on an immense number of practical points. Experiments made with certain specific ends in view, which will answer our questions in a reasonable time, are very much needed. This was the underlying idea of the permanent sample cuttings which I proposed a few years ago, and which were undertaken in the East. I have been of course sorry that those could not have been continued, for they would have resulted in practical information. Experiment stations in the several States and at the forest schools will doubtless have to work out this problem in the East.

It seems to me that a serious defect in a good deal of the silvicultural work we have undertaken is that there has been a lack of *definite aim* in it. Our *silvicultural policies* have not yet been clearly formulated. We have not yet agreed upon the underlying principles of American silviculture. We are not agreed as to the proper silvicultural treatment of State forests in the Adirondacks, and this disagreement has led to a notable suit now in progress of the State against the Brooklyn Cooperage Company, a suit which hinges on what constitutes correct silviculture on the State forests of New York. It is equally true that there is emphatic disagreement as to the principles of handling large private tracts in the Adirondacks and elsewhere, disagreements not of details of marking timber, but of fundamental silvicultural policy.

In Europe there have been developed so-called silvicultural systems under which the different types of forest are handled. The silvicultural system is a consistent scheme of cutting the mature timber and reproducing the stand, applied to a whole or a part of a forest. As a forest contains different types which require different methods of treatment, there may be several silvicultural systems carried on in the same forest. A silvicultural system is a broad plan of operation and the details of the work necessarily differ according to the local conditions. When a forest is organized, the forester determines what its ultimate possibilities are. He studies the silvics of the trees and the most desirable composition of the forest. He determines further the form of stand best adapted to carrying out the fundamental principles of management. He then operates his forest with a definite end in view and he uses a plan of work which will bring this about in the best possible way. And this is the real essence of a silvicultural system.

When forestry was first discussed in this country, naturally many went to European sources to ascertain the methods of silviculture and found various silvicultural systems. These were advocated for our forests and many of them found inapplicable as practiced in Europe. But at the present time we have no other scheme of silviculture; our foresters actually use the European scheme as the foundation for their work. They study how these systems are carried out in Europe and they learn the European point of view in regard to their advantages and disadvantages. They are taught the American names for them; that is "stand method" instead of "shelterwood compartment method," etc. But when it comes to the practical application of silviculture in this country the young forester finds that there are only a few places in which he can clear cut and replant; that the stand method requires permanent roads and a constant market for all products; that most of the clear cutting systems with natural reproduction are impossible as they are conducted in Europe because we may not be able to clear cut the forest at all; that there are but few places where the coppice method can be carried out as in Europe; and that the selection system is regarded in Europe as a very poor method except in the mountains, where there must be a constant cover. He becomes discouraged and usually ends by cutting to a diameter limit. This is essentially a wrong point of view and is the result of not appreciating the fundamental principles of European silviculture. It is the result of the confusion of the various modifications and present methods of applying silviculture with broad principles. It is the lack of clearly defined silvicultural systems and their application in this country that has led to confusion. And this is the cause, I believe, of the lack of definite purpose which characterizes a good deal of American silviculture.

The lack is particularly seen in silvicultural work on large areas where the problems of lumbering seem at first to be more important than those of silviculture. I do not think that we always recognize just how far we are practicing forestry and are apt to consider that we are practicing conservative lumbering and not silviculture. The marking is often done more with a view for the present than for the future. The marker often does not know the ultimate purpose of his work and he has little idea of its probable results in the long run. His general idea is to cut conservatively, possibly providing for the distribution of seed, but with little further idea of his work. In other words, we have no clearly formulated silvicultural policies to follow. Working plans have received a setback in this country. There is an impression that the working plan is a very involved and intricate affair. It is usually impossible to develop a complete working plan before beginning operations on a large forest, but this does not mean that one should disregard the essence of the working plan, namely, the fundamental policy of silviculture. If we take our National Forests, for example, it will take a long time to develop complete working plans for the whole area. The Indian Forest Service has been working now for a great many years and has working plans for only about thirty-five per cent. of the Goverment forests. This does not mean that the cuttings are deferred until the preparation of the working plans. The contrary is true, but cuttings are made with a clearly defined purpose. There is an underlying policy and the officer who has charge of the marking is working with a definite purpose. I once heard a forest officer in this country say that he did not know whether his cuttings were with the view of securing reproduction or primarily with a view of conserving the medium-sized growth, in order to return for a second cut at a comparatively early date.

We need in the first place a clear understanding of the fundamental policies underlying our practice of silviculture. In organizing any forest, the officer must have a definite plan underlying his proposals, which is usually expressed as a silvicultural system. When American foresters have developed their silvicultural systems, it will be found that they are essentially the same as in Europe, but with different application at present. An agreement on these fundamental points would dispel many misconceptions and tend to improve the quality of silvicultural work in every way.

The next point I wish to make is that while we recognize that we are aiming to secure certain definite results in the future, it is not good silviculture to undertake to bring about these results too rapidly. One of the fundamental principles of silviculture is to adapt our methods to Nature and not to try to make Nature conform to our methods. I think that the French have this idea better than perhaps any other nation which is practicing forestry. Their methods are characterized by a great simplicity and there is always the underlying idea of adaptability to local conditions. I say that we must have system in our work, but we cannot transform a forest at once into one of high productiveness. Suppose that we decide that a given form of forest is best adapted to our purposes in a given case; it will probably be a great many years before the desired results can be accomplished. We may know, for instance, that even-aged stands are best for the production of a given species, but we have to begin with uneven-aged stands and perhaps broken-down and ruined stands. These must be led over gradually to the desired condition. The theorist is apt to exclaim, "What is the use of waiting all this time? Why not clear cut and replant? The investment will pay and there will be ultimately a stand of enormous value." This is, however, usually not practical and no such sudden transition can be made.

In some of our forests, particularly those of the all-aged character and composed of tolerant species, the present form is well adapted for high production. The selection system is not only adapted for the present conditions but will in the long run be the system to be used. In many other forests the aim will undoubtedly be to bring about even-aged stands and the gradual introduction of one of the even-aged stand systems, as the market conditions permit a more complete use of the timber than now. Our silviculture will, therefore, be in the nature of a conversion, beginning with the selection system and aiming ultimately to use many of the other systems. I think that we may characterize the American silviculture of the immediate future as being for the most part work of conversion. It is like Indian silviculture. I have seen stands there which were being treated under the so-called compartment system. The forest had not the slightest resemblance to those in Europe treated under this system. What the foresters were really doing was to make selection, reproduction, and improvement cuttings with a view of ultimately bringing about even-aged stands which would be treated under one of the stand methods.

I should like to emphasize that the first selection cuttings which are made in any such conversion essentially constitute proper silvicultural work. We are obliged by the difficulties of our market to begin with very crude methods of cutting. I do not think that we are justified in saying that forestry is impractical because we have poor markets and that, therefore, we must practice straight lumbering. What we must do is to make a beginning, but we must make this beginning with some definite purpose. It may be that the market conditions require us to violate some of the principles which are emphasized in European forestry. Thus, for example, we may have to leave the ground to a certain extent in possession of less desirable species at the risk of an interference with the reproduction of trees we desire. We may not be able to locate the cuttings exactly as we wish. I do not, however, have any fear in regard to the outcome provided the forester understands just what he is doing, has a purpose in view, and appreciates that he is practicing silviculture and not merely lumbering.

Another point which I would like to make is that the silviculture which we can practice now will not have so good results as many suppose. It is true that we have the advantage in this country of excellent natural reproduction, at least in the humid regions. But it must be remembered that in just those sections the reproduction of brush and weeds is also excellent. In Europe methods of natural reproduction are intensive. They are successful because they are intensive. The crude imitation of them will not have results at all comparable to what is accomplished in Europe. Take, for example, the method of reproduction on clearings. We have been usually satisfied with guaranteeing the distribution of seed, and the information is often given that reproduction will follow certainly and in satisfactory amount. Many are going to be disappointed when they find brush or some inferior species occupying the ground and learn that it is impossible to secure a stand of the desired species without improvement work which will be expensive. White pine in some of our eastern regions is an illustration. Frequently clear-cut areas will be followed by hardwoods, scrub oak, huckleberry, etc. The white pine will creep in if there is a distribution of seed, but it will be impossible to secure a satisfactory stand without cleanings to protect the young growth in the competition with undesirable trees and forest weeds.

I think that we are sometimes in too much of a hurry to begin cutting. It is certainly distressing to a forester to see a lot of old timber which is now merchantable obviously beginning to deteriorate with little likelihood of use. It is a fundamental principle with us to use this material and not permit it to go to waste, but I think that we have sometimes been carried away with this idea and run the risk of making sacrifices in order to utilize this old timber. It is, of course, the excuse of the lumberman, who seeks a contract, that the timber is all ripe and will be useless in a few years. Some trees will die, undoubtedly many will deteriorate in the next ten to twenty years, but it must be borne in mind that stumpage values will go up all the time and that the holding of the timber may result financially in a much greater return in ten years than any possible loss by the death of a small percentage of the trees. Moreover, with this increase of stumpage we will be able to introduce restrictions in the lumbering which may not be possible now and which mean a good deal to the welfare of our forests. One sometimes hears the expression that in a virgin forest decay offsets increment. So it does in an ultimate forest type, but the majority of our forests are not in the ultimate but in the transitional stage. I believe myself that on the whole our National Forests are gaining enormously in increment and that, if fires are kept out, the increment will very much exceed any loss through decay. This is, to my mind, an exceedingly cheerful consideration and points directly to conservatism in cutting.

We have now in our profession a very substantial number of thoroughly trained and experienced foresters. As these men are nearly all in this Society, it seems to me that it is our duty to take, as a Society, a much more active part in promoting the science of silviculture and other branches of forestry than hitherto. There is a great deal of valuable information in the hands of individual foresters which has not been brought together. What knowledge we have has not been systematized. I feel this particularly in my work as a teacher. The difficulty of learning just what is being done on the National Forests and elsewhere, constitutes a real problem in training our young men for American work.

The new publication of the Society has for its object the bringing before the profession all the information possible about the principles and application of forestry in this country. The presentation of this information and its public discussion will result in an agreement on technical principles and in the establishment of silviculture on a firm foundation.

MANAGING A NATIONAL FOREST FROM THE BUSINESS STANDPOINT

* THEODORE SALISBURY WOOLSEY, JR.

Delivered before the Society April 2, 1908

While many of the points which I propose to take up will be rather commonplace, yet some of the views may be interesting to the members of this Society and may contain some suggestions for general discussion. Although some of the views are far from original, yet they are possibly worthy of record as an indication of Forest Service administration at this time.

Briefly stated, the main points of an average business are as follows: (1) supply of raw material; (2) production for market; (3) advertising and securing a market for manufactured material; (4) depreciation of plant and maintenance. It will be my endeavor to treat the Forest Service along these lines. The supply of the raw product is the grass and timber, and the production for market is chiefly the protection and patrol of the range and the details of timber sales and administration. The advertising for market is replaced by the control of public opinion, since if there were a universal adverse sentiment against the administration of the National Forests, it is certain that a change would be made; in other words, there would be no market for the product of the Forest Service. Depreciation of plant and maintenance is of comparatively small importance, since the value of permanent improvements amounts to almost nothing in comparison with the gross revenue and the estimated value of the raw product. The future supply of raw product, an efficient personnel, and a favorable public opinion seem to stand out as the main features of the business.

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* This paper was written by Mr. Woolsey in January, 1908, and was read by Mr. H. A. Smith, April 2, 1908.

When it is realized that the National Forests are proclaimed primarily to conserve a timber supply, it seems astounding that no active aggressive steps have been taken to protect local timber resources against over-cutting. Of course there is the actual administration which at present must come first, but would it not be reasonable, for example, to ask that the number of purely commercial timber sales be limited in order to secure men for preliminary working-plan reconnaissance? In the Southwest, especially, it is already doubtful if the accessible *available* supply is being properly conserved, and I hope to see in the near future the establishment of an Office of Working Plans with sufficient authority to see that the plans are properly enforced. This work will require men of the highest practical and technical ability in order that it may be launched on a sound basis. The guarding of its raw material—timber—is the paramount duty of the Forest Service, both from a business and a national standpoint, and in some localities I am firmly of the opinion that it is not being done. I fully realize that in many instances this conservative policy will meet with great opposition, but it is absolutely necessary and can not be overlooked.

Steps are being taken to improve the quality of the marking of timber and this is an advance in the right direction, and yet it is not rules on paper but actual supervision and instruction in the field that must raise this standard. The correct marking of timber can not be gained from official instructions, but must be secured by actual practice under a higher class of technical supervision than is usually secured. In this one point alone it is believed that ranger schools (modified to meet practical requirements) would be justified, since much of the marking must for some time be done by rangers without even the supervision of a technical assistant.

The conservative use of the range has been far more closely adhered to than has been the protection of the future timber supply. Most forest officers have been prevented from overstocking their range and there is a marked general improvement. I may be wrong, but I believe hardly a timber sale has been rejected on account of the danger of local overcutting.

Large business concerns are rapidly concentrating and combining since this has been found to lessen the cost of production. One of the very live problems of the Forest Service is whether to increase the number of supervisor officers or to have large central offices under the charge of extremely able supervisors with local deputy supervisors to oversee those forests too far from the main office to permit of frequent inspection by the officer in charge. It can not be disputed that as far as cost is concerned, and in some cases, as far as efficiency is concerned, the large supervisor's office with control of an extensive territory will give the cheapest and best results, provided the man in charge is a capable, energetic administrative officer. Yet the trend is undoubtedly toward small local offices on account of their convenience for the users of the Forest, who, for the most part, are poorly educated settlers and who prefer to come to the supervisor's office and talk things over personally, rather than to conduct their business by correspondence at a distance or take up the details of their applications through a local deputy supervisor. This seems at present to be undoubtedly the best policy, since public opinion must be catered to or the whole undertaking will be a failure. One can see that the district inspection officers will gradually assume additional semi-administrative details which before were carried on by the Washington office. In the near future, it is believed, it will be found advisable to place special use cases, timber sales, and other branches of work such as the distribution of supplies, under the inspection office. In this way the evils of having a lot of small supervisor offices in charge of men who are not altogether efficient administrative officers will be counteracted by close, constant, efficient inspection and advice.

From the business standpoint, inspection reports give inferior results and entail a waste of time and energy as compared with personal advice and coöperation. A prominent mining engineer once told me that when called upon to investigate a poorly managed mine he got the best results by running it himself for awhile, was surer of his deductions, and saved his own salary as "inspector," since he paid for it as an administrative officer. It is believed that with three months at the inspector's disposal to inspect an important office, that has been badly mismanaged, the best results could be obtained by actually running it as supervisor, with possibly the aid of an extra clerk to assist in reorganization routine. Where an office has been fairly well managed a general tour, followed by suggestions and advice and backed up by a concise report, would be most successful.

In any business the man in charge is a factor for or against success and this is doubly so in the Forest Service, and the personnel problem is of the first importance. The extremely clever scheme of having technical assistants and district foresters is turning out trained men rapidly, and yet every supervisor must realize that the real success of his administration must depend to a great extent on the quality of his ranger force. Higher pay and more comfortable quarters are steps in the right direction. The need of a ranger training school in the West is felt by some supervisors to be advisable and the methods used by the Atchison, Topeka & Santa Fe Railroad Company in training and developing certain kinds of personnel material might be imitated. It might be feasible to make certain Forests training schools for each district and give the men a thorough, general training (after appointment as guards) in routine before putting them on actual work. As far as can be learned it has not proved very successful with forest assistants, since they were not given a *general* training but were merely used on urgent work along one or two lines. Personally, I believe in an even higher paid grade of rangers than we have at present, with a possible reduction in the general authorization for salary and a much higher amount for hiring temporary laborers for special work other than administrative routine, to be carried out under the direction of the district rangers. With higher salaries the higher grade of officer will come in gradually. Especially in the West, where bright men can make money by leaps and bounds, the salary problem is all-important, particularly during flush times.

Of course the vital personnel problem is to secure efficient forest supervisors, and this will become more and more difficult unless some drastic change is made in the present scale of salaries. Good all-around energetic men with business ability will not be retained unless better salaries are paid, and even the training of technical men as administrative officers will not meet the deficiency. Possibly the higher officials do not realize that the increase in routine (especially Act of June 11 claims) has added tremendously to the work. In the future, with detailed working plans to follow and a higher technical standard, there will be even a greater responsibility and need of real executive ability in the officer in charge. One supervisor at least feels that the Forest Service has been "getting something for nothing" and has held the good men by making promises of a higher scale of pay which have not materialized. It seems reasonable that at the start if a man "makes good" he should receive more than the proverbial $200 increase in salary. Suppose a new man starts in at $1400 and has successfully handled for a year a $2400 office, why should he not be promoted to $1800 or $2000? If he is doing the work, why should he not receive the salary?

In the Army, if a captain is promoted to colonel on account of gallantry he receives a colonel's pay at once and then a stated increase based on length of service.

Simply on a business basis the position of supervisor seems to be worth $1800 to $3000 and in rare cases possibly $3500. Of course the Forest Service is looked upon as a technical bureau and hence comes in for a low salary schedule, and there are undoubtedly political reasons why higher salaries are difficult to grant. But some officers in charge at least feel that, whatever the difficulties of securing a higher scale of pay, they are entitled to the money they are really earning.

Compare the salary of the average supervisor who is working ten to fifteen hours a day with the salaries of men in other branches of the Government, and the disparity becomes striking. Possibly the fairest comparison is with registers and receivers in the local land offices. They work eight hours a day and usually net $3000 a year, and often have remunerative private interests. There is one who is president of a bank in addition to holding his government position.

While higher salaries are favored, yet at the same time one can not help feeling that usually it is best for a forest supervisor not to be interested in stock, at least on his own Forest, and this is a problem that will some day have to be threshed out and settled once for all.

It is well known that a great many business houses keep a permanent record of their employees' work and a close check on all purchasers. Are their payments made on time? What has been their past record in paying bills? Can their statements be considered reliable? Would it not be advisable for officers in charge of forests to keep a confidential record of their rangers? When the policy of transferring men from small to large offices as a means of promotion becomes effective this would be especially valuable, since these data will be lost when a man leaves his Forest unless some record is kept. I see no reason why the Government should not take this means of protecting itself against unreliable employees and of giving final recognition to faithful rangers who are not especially brilliant but who have done careful, painstaking work.

The cost of operating our offices has been too high, and a tremendous amount of time and energy is spent by every forest supervisor in correcting forms, rewriting reports, and such trying details of administrative work. It seems extremely desirable from a business standpoint to lessen the chances of making mistakes and yet to attain even a higher standard of efficiency. For instance, would not the style of letter be vastly improved if a short book of sample letters and sample reports could be issued, including quite a large number of samples covering almost every form of letter that is written to the Washington office? It would of course be understood that these letters need not be followed exactly but be merely used suggestively. Exact form letters might be prepared for certain reports which are routine in character. The Office of Grazing has from time to time issued sets of sample forms showing how permits should be filled out. On the back of each form there has been, in addition, a brief memorandum covering its use. This method has proved extremely successful, and it is one which might be followed in simplifying the completion of almost every form. These sample forms could be bound together for general distribution. It is usually simpler to follow a sample rather than to fill out a form on the basis of general instruction.

Every change that is made in the Use Book takes some time to find its way into the heads of most rangers and some supervisors. Would it not be advisable, when the new volume is published, to issue a special circular calling attention to every change?

From time to time during the year, especially in the Field Program, great numbers of official instructions and memoranda are issued, and it is safe to say that very few forest officers keep strictly up to date; and new officers who are just starting in only discover past instructions by making mistakes. I have found it necessary to make a digest of every instruction paragraph in the Field Program, circular letter, and Service Order to keep up to date. Would it not be advisable to issue at the end of the year a digest of all instructions of permanent value which have not been superseded by new ones? In the past, it has been supposed that these are included in the new issue of the Use Book, but it is certain that this has not been done.

The sale of forest products can never be on a strictly financial basis with the exception of the price for timber, and it is freely admitted that the Forest Service has raised the prevailing stumpage rate considerably throughout the West. The policy of charging only part value for special uses and grazing, and allowing certain classes of privileges free of charge, is undoubtedly correct since it caters to public opinion (advertising), and favors the small resident settler. While it is believed that the cost of operations is considerably more than it ought to be, yet the additional cost has probably been well invested in educating forest officers for higher positions. Of the different lines of work the cost of examining agricultural claims (Act of June 11, 1906) seems especially high, and I understand in some cases the cost per claim had been $25, and even $50 in exceptional circumstances. A closer supervision of the cost of each man's work should be made, since at present, a man's efficiency is judged solely by results, instead of results plus the cost of attaining them. In any large business the cost of production is closely scrutinized. In the Forest Service, with a few exceptions, the actual cost of conducting timber sales and free use, issuing special use permits, examining claims and the amount of time lost in policing camp, securing mail, loss through bad weather or aimless patrol are not determined. These are figures which every forest supervisor should have at hand in judging the work of the rangers under him. Just from curiosity I compiled such figures for one of the Forests under my charge and secured astounding figures on the work of men considered quick and efficient. While the addition of red tape is extremely undesirable, yet cost figures are one of the prime factors in conducting any business economically. But of course before judging a man's work allowances would be made for varying conditions and for local adverse circumstances which necessarily make work more expensive. Yet if one examiner during a year inspects agricultural claims for $10 each while another spends $30, there is certainly need of knowing it.

Settlers rarely realize how much they are receiving free or at a nominal cost. I remember the amazement of a "homesteader" who had already exercised his homestead right, but who desired to take advantage under the Act of June 11, 1906, of an additional right, and who desired to secure by purchase ($2.50 an acre) some land for pasture which was not strictly agricultural. He could hardly believe it when he discovered that interest on his money and county taxes would cost him about 30 cents per acre per year, while he could secure exclusive use of this pasture by renting it from the Forest Service for 10 cents per acre per year. These points should be widely advertised throughout the West and especially brought to the attention of the settlers through the small local newspapers.

The work of making a desirable contract is perhaps one of the keynotes in a successful business. A stiff contract with impossible clauses, which places everything in the hands of one company, is certainly a powerful weapon in making money and is practiced by many corporations. In the Forest Service this is especially true in timber sales, and it has undoubtedly "put the control in our hands" in many cases where a company unwittingly has signed contracts which contained impracticable clauses. It seems, however, that the Government can not act as though it were a private corporation, and it ought not to require impracticable clauses which can not be carried out in practice.

It is especially in timber sales—now that considerable power has been gained—that care should be taken in not asking for expensive work which some years hence will have the effect of reducing the stumpage price. We should be especially careful in not requiring symmetrical brush-piling, for example, when less expensive work might give the same results. A forest neat and attractive to the eye after lumbering is certainly desirable in many ways, and yet, if silviculturally it will not give better results, the Government will be unbusinesslike to require unnecessary work which costs the lumbermen money. I have often wondered if complete brush-piling is in all localities worth the money it costs. For example, in the open yellow pine forest of the Southwest, such as is covered by the Greenlaw Lumber Company, timber sale, in the Coconino Forest, would it have been to the advantage of the Forest Service to have received $45,000 more for stumpage and not have required brush-piling? Could this area have been protected at an expenditure of say $30,000, thereby saving $15,000? Would the cutting area have been in better condition for reproduction and have been safe from fire? Would brush-piling on alternate sections or in half-mile strips be adequate?

Quite recently there have been a number of coöperative agreements of varying descriptions; trading seed trees for stumpage, proposed trade of land for stumpage, tilling the ranger stations for a portion of the produce (usually one-third), exchange of stumpage for finished lumber, free right of way for telephone lines in exchange for free use, and coöperative administration of railroad land. Possibly coöperative agreements are inadvisable on the part of the Government and it seems that this is especially so regarding free telephone rights of way, since it is seldom that a free right of way is sufficiently valuable actually to promote construction where otherwise the line would not be established. As a Government business policy, it seems altogether preferable, for example, to charge a uniform price per mile for the telephone right of way and to pay a regular fee for messages. In this way all the companies would be charged on a uniform basis, while on the present basis the charge varies according to the amount of service the Government receives, which of course fluctuates tremendously according to locality. However, the good will of the company and the coöperation in fighting fire might partly even up matters; yet solely from a financial standpoint each proposition ought to be judged on a dollar and cents basis instead of having a uniform system for or against coöperative telephones.

Where ranger stations are tilled for a portion of the produce it creates disparity between the cost of living of the different rangers, since those not provided with desirable stations where it is feasible to rent the land have to buy their hay and grain, while others with tillable fields may secure fodder free of charge. It raises many complicated questions. For example, can a ranger trade his supply for corn and for hay? Is it fair to require him to supply other Forest officers, since in so doing he may run short of produce towards the end of the winter and have to buy it out of his own pocket? Of course there is no objection to the coöperative management of land, exchange of seed trees, etc., provided it is on a strictly business basis and is not too complicated, but, on the whole, it is my opinion that coöperative agreements are not advantageous. It seems to me that the Forest Service should pay for what it gets and charge for services performed.

The recent move in being more liberal regarding expenditures for permanent improvements is of extreme value, and yet even the present scale is not so liberal as it should be, and there is too much individual variation in construction, especially of the cabins. Where cabins are constructed of lumber some tasteful, simple plan, drawn up by a competent architect, could be used as a pattern to be varied to meet local requirements. The small cost of preparing these plans would be more than paid for in economical construction and especially in having comfortable, practically arranged buildings to live in. The quality of buildings has a direct bearing on securing good men on the permanent ranger force. The comparison of Forest Service quarters with those constructed by the War Department or the Office of Indian Affairs is extremely discouraging and there is room for tremendous improvement. A glaring example of the low grade of Forest Service improvements may be illustrated by the fact that it is very seldom that a painted dwelling house can be found. Economically, on account of durability and from the standpoint of appearance, it seems reasonable to ask that the Forest Service erect painted dwellings at least as habitable and as pleasing in appearance as the average section house on a railroad.

There is need of more definite instructions regarding the general financial policy for the current year. Supervisors must know approximately what their share is for permanent improvements or salaries before they can plan the detailed expenditures to best advantage. The control of expenditures must be aggressive and systematic to give the best results.

Of course, in most of the forests the final demarcation of boundaries is still subject to modifications, but, comparing our system with the very permanent corner posts and lines established in British India, the Forest Service is extremely deficient in its boundary posting. The regular weekly improvement reports required by the Office of Engineering are a brave step in the right direction, and, although they may need modification, yet they are only what any business man would require of those spending his money.

These remarks are not given in a spirit of criticism, since it must be admitted that the Forest Service is one of the most efficient administrative units of the whole Government and that needed changes are being delayed merely on account of insufficient funds or lack of officers. There has been accomplished in a few years what it has taken other countries decades to secure. Great progress has already been made, but the conservative use of the raw product of most importance—timber—will only be solved by the establishment of an Office of Working Plans, and then only after years of experiment and practice, and with the earnest cooperation of the local officers in charge.

SIR DIETRICH BRANDIS

GIFFORD PINCHOT

Delivered before the Society April 9, 1908

It is a real pleasure to meet you again after having missed so many meetings. I am sincerely glad of the chance to talk to you to-night about Sir Dietrich Brandis, one of the greatest of names in forestry. Perhaps the best way I can introduce what I have to say about him is to describe how I first came to meet him, if you will pardon a personal reminiscence, and then I shall speak more in detail of his life and work.

A good many years ago I found myself in London with an extra day on my hands. I was just setting out to study forestry, and so I thought I would go to the Indian Office and get what information I could about forestry in India. Most fortunately, for I was entirely without introduction of any kind, I found there a gentleman who was kind enough to procure for me a letter to Sir Dietrich, of whom I then heard for the first time. I went at once to Bonn, found Sir Dietrich one afternoon, told him I wanted to study forestry, and asked for his advice. Instantly he adopted me, so to speak, accepted the care of directing my work, and immediately began to tell me how to set about it. I remember his deciding that I should go to the Nancy Forest School, which was my plan already, and when I said to him that I was ready to go, he immediately began to look up trains. I saw that one started at six o'clock the next morning, and as I wanted to make a good impression, I said I did not mind getting up early, so as to catch it. He replied, "Of course you will take the first train." I have never forgotten the impression he gave me then of his absolute willingness to do whatever was required for his work, and his expectation of finding the same willingness in other men.

Since that time I have come to know him very well indeed, and to have the highest respect and regard for him; and it is a great pleasure to talk to you about him. Whatever good fortune I may have had in forestry I owe in very large part to the kindness of Sir Dietrich in taking charge of my preparation for the forest work, and in keeping in touch with me until his death.

Curiously enough, Sir Dietrich Brandis, who at the time of his death and for a long time before was the chief figure in the forest movement in the world, began not as a forester, but as a botanist. He was born in the city of Bonn, April 1, 1824, and after studying at the Universities of Copenhagen, Goettingen, and Bonn, became a teacher of botany in 1849. During his work in forestry he never lost his keen interest in botanical work. He followed his studies in botany in Germany for a number of years, and then through a train of circumstances which originated in the desire of the Government of India to find a man who could take charge of the forests, he was offered by Lord Dalhousie a position as forester in Burma in 1856. For some years before that time medical and army officers had been practicing a rough kind of forestry under adverse circumstances, so that in a sense the Indian Forest Department had started before Brandis went to India, although it had made very little substantial progress.

No really systematic forestry had been introduced in India when Brandis became Superintendent of the teak forests of Pegu in 1856. From the first he met the same kind of opposition that forest work has met in the United States. It continued throughout his active service in India, but it never passed beyond his control. The first skirmish was won in Pegu. In 1857 the rest of the Burma teak forests were put under his charge, and from that time until 1862 there was a continuous warfare between the Forestry Department and the teak merchants, who maintained that the forests were inexhaustible, and that restrictions were needless and meant ruin to their trade. One of the stories Sir Dietrich most loved to tell was of how the policy which saved their business for these merchants by giving them a continuing supply of teak was the very policy which at first they so bitterly opposed.

We are all familiar with the method based on the circumference measurements which he adopted for regulating the cutting of the teak. That was one of the first steps of his professional work in India, and like all the rest, it has stood the test of time.

Immediately on taking charge of the work in Burma, the qualities that afterward made Sir Dietrich the first among the foresters of his time began to find their natural exercise. The power of his manhood, which was tremendous, began at the same time partly to evoke and then to overcome all sorts of difficulties. The warfare against him and against his methods of work which began in Burma was carried into other parts of India as he was transferred from place to place, and his whole administration was one of struggle and victory. His debt to Lord Dalhousie and Sir Arthur Phayre during this long encounter was one which he loved to acknowledge, and I have heard him refer to it with feeling on many occasions.

After Brandis had confirmed his first successes the demand for his services throughout India became pressing. In 1862 he was called to Simla for a conference to discuss the general forest situation. In 1864 he was appointed the first Inspector General of Forests to the Government of India. In 1881-83 he went to Madras, so that successively he organized the forest work in Burma, Bengal, Bombay, Madras, and then afterwards in some of the other British colonies. In 1883, after a career without parallel in the annals of forestry, he retired. Before his retirement there was an interval, which I am not able to place, during which he devoted himself again to botanical studies, and then resumed his work in forestry.

Brandis' services were twice conspicuously recognized by the Government of India. In 1878 he was made a Companion of the Indian Empire, and in 1887 a Knight Commander of the same order. He was throughout his service distinguished as taking his place naturally and inevitably among the leading men, and these conferred distinctions were highly prized neither by him nor by his associates. He was a far too large a man to be greatly honored by any decoration.

The parallel between the forest work in India and in the United States is a very striking one, and I have always believed that American foresters would do well to study in India as well as in France, Germany, and Switzerland. Very early in India, as happened here with us, the need of educated and trained men was felt, and in 1886, with the permission of Lord Salisbury, Brandis began the policy which provided the Indian Forest Service with most of its best men. In that year he began to select young Englishmen and put them at the French and German Forest Schools, and especially at Nancy, to get their training. This policy lasted for twenty years, and it was while it was in effect that my acquaintance with Sir Dietrich began. In 1872, in addition to this method of training English foresters on the continent of Europe, Brandis began to fill the inferior positions in the Indian Service with the natives of India, and this has been a potent means of giving a strong administrative force to the work.

With the foundation of the forest school at Coopers Hill in 1885 the training of English students on the Continent was in large part discontinued. This was done somewhat against the protest of Sir Dietrich. The school was put in charge of Doctor William Schlich, who had succeeded him as Inspector General in India. From 1888 to 1896

Sir Dietrich took charge each year of the graduating class of the school for six weeks or two months, and spent the time traveling about with them in the different forests of Europe. This excursion came between their graduation at Coopers Hill and the beginning of their work in the field.

The impression made upon me by my first experience with Sir Dietrich and those English students I shall never forget. He had just taken charge of a class fresh from Coopers Hill at Aix-la-Chapelle (this was in 1890), and I joined them nearby. The next morning we started out after an early breakfast, and Sir Dietrich took us on a steady hard walk, without rest or food, for eight hours through the forest, himself intensely interested from the beginning to the end, but leading a body of young men by no means so intensely interested. His spirit of devotion to the work he had not yet time to impart to the students, and I think I have seldom seen an angrier group than those young Englishmen. My own impression was that if Sir Dietrich, a man of sixty-five, could stand it, a man of twenty-five ought to be able to.

These trips with the Coopers Hill men led Sir Dietrich to write considerably about European, and especially German, forestry, and gave the students under him an opportunity, which they often did not use as well as they should, to become acquainted with the practical details of forest management. As we went about from one forest to the other, the forest officers in each district, when they could speak English, or Sir Dietrich himself, explained to us the details of forest administration and management. I think I have seldom worked harder than during that trip of six weeks and never with greater profit. It was an ideal method of finishing the training of men who were soon to be thrown on their own responsibility, and very much as our own men are now.

His connection in this way with the English students led Sir Dietrich very naturally to take charge of American students who came to Europe for study. Taking charge of a student meant with him not merely to advise as to the general course of study, but also to require bi-weekly reports, and to read and to criticise them, to send long letters written in longhand to each of us from time to time, and in every detail to try, with a never-ending patience, enthusiasm, an generosity, to see that each got from his work exactly what he came for. This was done for me, then for Graves, then for Price, Olmsted, Sherrard, and many others. Sir Dietrich thus had a guiding hand in shaping many of the men whose fortune it became afterwards to shape the general policy of forestry in the United States. So important did his connection with forestry in this country become that his correspondence with all of us must have taken a considerable portion of his time. We who were his students were all until the end more or less in touch with him and we were constantly referring in our own minds the problems which we had to meet to our conception of what Sir Dietrich would think about them, so that his influence in this country was a real and a very important one. It helped us in our work to feel a great responsibility to such a master in forestry, and if we had to differ from his point of view at times because of his lack of direct personal familiarity with all the conditions here, we took care always to be very sure we were right before taking action.

I do not need to explain to you the practical impossibility of getting a correct idea of the forest problems of any region without seeing it, especially a region not only whose forests are different, but whose whole political organization and methods of thought are different. It was necessary for many of us who had grown up under Sir Dietrich to differ with him about some of the problems we have had to meet here. One of the great satisfactions I have as I look back is that I was able at intervals to take these problems to Sir Dietrich, and to find that he was rounding to the point of view that we had come to adopt as the result of our experience on this side. We who knew him felt and shall always feel under the deepest obligation for what he gave us. So important did Sir Dietrich's connection with forestry in the United States become that the President recognized it by sending him a large photograph on which he had written, "In high appreciation of the work of Sir Dietrich Brandis for the cause of forestry in the United States. Theodore Roosevelt." The last time I visited him he had this photograph framed and hung in his room, and I never saw a man who took more open, simple, and well-earned pleasure in any possession than he did in that witness to the value of his work for America.

After Sir Dietrich's work in India was finished and he had retired, he lived partly in Bonn where he was born, partly at Kew, and continued to take a wonderfully keen interest not only in forest work but also in the revival of his botanical studies. His two greatest contributions to forest literature were "The Forest Flora of Northwestern and Central India," and his monumental work on "Indian Trees." Throughout his life his interest in the botanical side of his work came often to the front, and I think had a very important influence on his character. In other words, the extreme exactness necessary in his botanical work gave him and kept with him his wonderful power over detail, and his unflagging accuracy in his work.

Sir Dietrich's work as an administrator in India has had an effect upon the conditions of daily life which can only be understood when we grasp the wonderfully close relation of the forests to the Indian peoples. We in the United States often say that on no continent is forestry more necessary than here, and in general we are right when we say so. But there are certain respects in which the relation of the forests to the East Indians is more important than the similar relations which we have reached here. In British India the existence of prescriptive rights, or rights of user, in certain forests gives the population the right to take what timber and other forest products they need, and that without charge. When Brandis began his work, a very large percentage of all the forests in India were practically useless for all other purposes, because these demands of the people, made in pursuance of their lawful rights, took the whole product or even prevented the trees from growing to merchantable size. One of the great problems was to define and settle these rights, either by giving the people certain portions of the forest lands outright or by regulating and restricting their use of the forest. In other words, the first necessary step was to eliminate or curtail these rights far enough to allow the forests to grow. One of Sir Dietrich's greatest monuments is that he devised the system which did so, with justice and with entire success.

When he came to the organization of the executive and administrative forces of the Indian forests, Sir Dietrich found himself, even more fully than we find ourselves here, required to invent his own system, his own policies, and his own methods of carrying them out. How well he did so we all know. The good organization and the good spirit of the Indian Forest Service stand in the first rank among all his achievements. The organization differs in many ways from our own. You will recall that in each of the provinces of India, the Conservator of Forests is responsible directly to the head of the Civil Government, and not to the Inspector General. It is as though our supervisors were responsible, not to the Forester at Washington, but to the Governor of each State. Naturally the making of a homogeneous system under that difficulty was a large achievement. It was truly a most remarkable piece of work, carried out under every kind of difficulty, sometimes including hostility in the Government of India itself, which from time to time threatened complete overthrow. Once and again Sir Dietrich was obliged to fight for the very existence of the Service which he created. In the end he won completely. He will go down in history without question as the first forest administrator of whom we have knowledge.

Sir Dietrich kept the technical point of view in his work always prominently in the foreground. He made and sent to the Paris Exposition in 1878 a collection of Indian woods. He was in constant touch with the detail of his forests. In addition to the works of which I have spoken he produced a considerable amount of botanical and forest literature, and kept throughout clearly before him the fact that he was not only an administrator but a professional forester as well. I can assure you from personal experience that when a man is overwhelmed with administrative work and with conflicts of every kind, to do so is no small victory.

The systems of forestry introduced by Sir Dietrich are curiously enough taken as much from France as from Germany. Admirable as the German systems are for Germany, they have a degree of finish about them, an eagerness to reach perfection, a vigor of desire for complete execution of ideal methods, which unfit them for successful use in a new country. In France results are more considered than methods. Where preparation in Germany for forest work often takes six or seven years, in France it takes but two or three. The trained man in France may be less finished as a forester, but there is less danger that his executive capacity will be blunted by overrefinement and by responsibility too long deferred.

Sir Dietrich was not only a great forester. He was also a great deal more. I have always tried to impress on the forest students to whom I have spoken, at the Yale Forest School and elsewhere, that to be a good forester, a man must first of all be a good citizen, interested in everything that has to do in a large way with the progress of the Nation. Sir Dietrich was thus interested. He was preëminently a statesman, and his conception of the Indian forest policy as a means for nation-wide statesmanlike ends in India was greatly imagined and greatly carried out. Take, for example, his giving the natives of India responsible positions in the Forest Service. Natives of India taking part in competition for certain classes of positions with Englishmen born in India gave them a place and dignity in the Forest Service and elsewhere which they would not have had without Sir Dietrich's help. His interest in the natives was always of the most helpful kind. Their welfare stood higher in his daily thought than is at all usual, in any colony, with the men charged with problems of administration. By this treatment of them he won the support of the natives when their loyal assistance was one of the critical things needed for the success of his work. He understood and practiced the great truth that to make forestry successful the people who live in and near a forest must be for the forest and not against it, and in doing so he strengthened tremendously both his own position in India and that of forestry. From the same point of view I have often heard him speak with the greatest admiration and respect for what the missionaries have done for the natives of India, and especially the American missionaries. He was always keenly alert for what would be useful to the whole country. Forestry was not to him an end in itself, as it should never be, but a part of his general plan of work for the general good. Because he understood that thoroughly and practiced it, was one of the reasons of his great success.

I come now to speak more definitely of Sir Dietrich's personal character. One of his more obvious characteristics was a physical endurance which was almost unique. It was his custom on his inspection tours in India to walk through the tropical forests for from eight to twelve hours a day, and then sit up till late at night writing his reports or discussing forest problems with his officers. More than one Indian forester has told me that on these tours he left a trail of worn-out men. He would take a party of officers in one district, walk them into exhaustion, and then pass on to other districts and leave each successive set of officers practically spent. It was simply that this was the kind of day's work he was in the habit of doing. His working capacity in his later years was of the same kind. While the students were going with him through the forests in Germany in 1890, I well remember how we young men would turn in at night long before he did, and come down to breakfast in the morning sleepy, tired, and cross, and how Sir Dietrich would appear with a dozen letters he had written either after we went to bed or before we were up, and with an absolutely unflagging enthusiasm for the day's work. It used to worry me that the men who went with him did not seem to be able to share in his view of the importance of the things they were seeing. There was apparently no end to his capacity, either physically or mentally. Yet all his life he was a constant sufferer from serious ailments before which a lesser man would have gone down.

He was a man of a tremendous self-reliance. To accomplish what he did, he could not have been otherwise. He was a man of strong convictions, of a very fully developed religious nature and a great religious faith, a compelling belief that he was right, and a complete willingness to do whatever was necessary to carry out the work he had in hand. If ever there was a man to whom the idea "What's the Use?" did not appeal, it was Sir Dietrich. Whatever was necessary to achieve his end was worth doing, and that creative enthusiasm of his lasted to my personal knowledge until a few months before his death, and doubtless to the end. If we Americans had been working closely with him along our present lines, we should have thought him very conservative in his methods and in some of his ways of thinking. The longhand writing of letters was the only way he ever used, and I have often thought that he could have saved much time and energy if he had availed himself of modern means of work; yet his relentless industry accomplished at least as much actual routine as most of us can with every assistance.

His willingness to give himself completely to whatever he had in mind, led him naturally to assume that others who were really interested in forestry were willing to do the same thing; and thus he set so high a standard for the young men gathered about him that we often thought at first that he was hard. I thought so myself once, and I remember being profoundly astonished and equally delighted, when after a while the work began to tell, to learn that he had been watching my condition, knew all about it, and was at least as much interested in it as I was myself. But if it was necessary that I should use myself up, he intended and expected me to do so, because he thought every man should be willing to give all that was in him.

One of the keenest recollections I have of Sir Dietrich is of his charming manner, of his courtliness, of his punctilious observance of every detail that could be required by the highest courtesy, of his perfectly delightful way of drinking the health of his guests, and paying them the smaller courtesies which in Germany play so large a part in daily life, and which I wish played a larger part in America. He was one of the most perfect of gentlemen, and his consideration of the rights and feelings of others was always alert. His breadth of sympathy and interest remained unknown to me for years. Then I discovered that he was interested as much in political affairs as forestry, and that while in Bonn he constantly gave one evening a week to a workingmen's club which he had founded, and with which he discussed every current topic. He came to be well known in labor circles over a considerable portion of Germany, and once he said to me that he should have been a leader of the German labor party.

In his later years, during the revival of his botanical studies, he spent a considerable part of his time at Kew. My recollections of him there are most delightful. He had rooms in a cottage, Capel House, of which he was extremely fond. His associates at Kew were those whom he liked, and he was happy in living a life full of useful and pleasant days, greatly honored, and free from any responsibility except that of doing the daily work which appealed most to him in his old age.

There is a close relation which such a man necessarily holds not only to the forest work in his own country, but to forest work throughout the world. What Sir Dietrich did for forestry does not end with his great achievements for forestry in India and in the United States. We must look also to the prolific and continuing power of his having forced forestry into its proper place of dignity and respect. Forestry in India under Brandis made a forester the equal of any other man in the civil administration. He respected his profession as a great man should. His profound regard for it, his great achievement in it, his use of it for the general good, his capacity as a statesman, his character as a man, and his personal dignity all combined to give forestry a high position. That was a service to the cause of forestry that will long outlive all those who knew him. His next great service consists in having had a hand in establishing good forestry in many lands, in India, Africa, Australia, the British colonies, and in America. The influence of his methods, of his scientific integrity, his executive power and leadership, and his devotion have been felt wherever forestry is practiced. In all the forest work of the latter half of the nineteenth century and during at least the first half of the twentieth, no other influence will be so potent, no other man will hold so high a place in forestry as the influence and the place of Sir Dietrich Brandis.

INFLUENCE OF LUMBERING UPON FORESTRY

AUSTIN CARY

Delivered before the Society April 16, 1908

The writer, I believe, is the oldest man in that group of still young Americans who call themselves " foresters." As I think of the history of the past fifteen years I am struck with two exactly opposite views of it. The progress in some ways is no less than marvelous. That before the year 1908, 160,000,000 acres of national forests would be established there would have been few, I think, fifteen years ago able confidently to foretell. Forestry education too has become widely established and recognized, while more important than that is the place forestry occupies in the public mind. The whole country is sown with the idea; all classes of people are receptive and hospitable; even the hardest-headed business man is inquiring what there is in it for him.

On the other hand, when I think of the record of these fifteen years in some other lines, foresters seem to me to have been surprisingly blind, and the record of their achievements extremely small. I refer now to the application of forestry ideas to the actual management of timber lands. There are, it is true, a few pet and exceptional tracts in the country where forestry ideas in a detailed way are carried out. At the other end of the scale, too, in the way of state laws for protection and of favorable consideration on the part of the people, a great deal, as already mentioned, has indeed been done. Between these two extremes, in the actual control of the policy of large bodies of forest land, seems to me to be a very important field where foresters up to date have had very little effect. This has not been because of lack of attempts to do it. If every forester who has started out in a business enterprise had stuck to it and succeeded in it, if all the plans made and money spent had resulted as was hoped and intended, foresters and forestry principles would now be controlling a material percentage of the forest land of the country. As I understand it the results are not at all of that nature, and the fact is generally recognized.

It seems to me important at the present time that we look this matter squarely in the face, see what has been the trouble with our plans in the past and draw clear conclusions as to the future. This paper, as far as it goes, is meant to be a contribution to that discussion. That the experience and thinking of the writer have been mainly in this very line may be justification for entering upon it. Poor execution of the task may be partly explained by the fact that this paper in the main was very hastily prepared.

One reason why we have not succeeded better seems to me to be that few of us have really taken the point of view of the forest-owner. The owner of a piece of property is interested in it because of its value or income. Whatever will enable him to get more out of his property he wants. An expenditure that costs more than it brings in is to him a disadvantage. Stock maintained and future income assured he values, or most owners do, but present value and present income naturally figure larger in his calculations. *Now, it seems to me that foresters have laid too much stress on the future and taken too little account of income and expenditure at the present time.* That is a natural thing with their training, and the ideas they carry are the ones which business distinctly lacks, but disproportionate valuation of these things is a great hindrance to present and actual efficiency. To spend $5 an acre in extra cost of operation in order to save reproduction which may only secure an added value of $2 to the cut-over land is a proposition to which no businesslike man is going to be attracted.

What I mean to say is that foresters up-to-date have been mainly interested in demonstrating forestry principles abstractly, not in using their knowledge for the benefit of forest-owners. As I see it they have gone to the forest-owner with a proposition to demonstrate certain things at his expense, not with a genuine offer to put knowledge and service at his command. That may be a good thing to do in certain circumstances. For all I know, it may have been the deliberate, considered purpose of the men who directed those operations. But in my judgment it is a principle which will not be effective for any considerable length of time.

Secondly, it seems to me that we have *often professed and assumed to do more than from our position we possibly could do.* Just as in some States it has been assumed that good forest management could be secured by the passage of a few general laws, so foresters in many cases seem to have taken it for granted that forest management consists in laying down a few general principles on paper. We do not seem to have realized that after determining what should be done comes the work of actually getting it done, and that this is much the more difficult and important matter. It is told how in the civil war an old lumberman actually built a bridge for an army to cross over before the engineer corps could get round to draw the plans for such a structure. Now foresters seem to me to have been largely working in a parallel way. While they have been making beautiful plans for the management of forest property, the plain men on the ground charged with actual responsibility have been actually managing the woods, mainly according to their inherited lights and training. I do not see how this matter could well be otherwise as long as foresters do not assume direct control. Good forest management is not more a matter of correct principles than it is of efficient handling of local circumstances. Still more is it a matter of actually getting things done,—in other words, of good business organization and management. And the man who stands outside and expects to handle things at long range is, in my opinion, choosing a very disadvantageous and ineffective position.

I may be wrong, but I have the very strong feeling that at least those hard-headed business men who are the owners and controllers of a large share of the country's forests never will pay any particular attention to a man who is not in their own pay and employ. The reasons are many and convincing. They know in the first place that men never will be sure of their ground, never will distinguish the merely plausible from that which will actually do the work, until they have tested their ideas by experience. They know further that local circumstances and the working organization are very important elements in the case. Again, they are firm believers in the idea that nothing so promotes caution and thoroughness in most men as to have their own interests directly involved. Lastly, they want a man to stay in given circumstances long enough to profit by his own mistakes.

The upshot of what I have said is that nine-tenths of good forest management turns on the men who are in actual charge on the ground. Plans for them to go by may make some improvement, but the character and training of the men themselves are the main thing. The actual woodsmen are to my mind also the foresters of a country, and if in the United States technically trained men ever expect really to control the destiny of the forests, they have got to be in positions of that kind, and their make-up and training must be such as to render them efficient therein. The situation in my opinion is hospitable for men of that type. What will actually happen depends on the men.

The third reason why the efforts of foresters for management more nearly in the line of forestry principles have resulted in so little is the fact that they have not as a rule understood lumbering operations on the mechanical and financial side. A thing may be desirable in itself and yet cost so much that a man is better off without it. Now foresters in my experience of them have been mainly oblivious to this matter of cost as represented in lumbering operations, and further than that seem to have paid no sufficient regard to the silvicultural effect of lumbering operations of different types. This is, in effect, to concentrate attention on the end to be gained without proper consideration of the expense or the means by which it is to be secured. This was perhaps unavoidable with their training, and it was placing emphasis where emphasis clearly needed to be laid, but in my opinion it is a matter which has hampered us heavily in the past in the way of securing actual results, and it must in the future be definitely discarded if anything like due results are to be obtained. This whole conception of a forester who is not also a lumberman as far as I know, is both temporary and local. The German forest officer is not such a man. In school he is carefully trained in lumbering and in all such engineering subjects as concern him, and when he leaves school he goes to managing his forest, on forestry principles to be sure, but also from the business point of view. He makes the best of the market; he has his working force under thorough system and control; when he plans an operation he has in view not the silvicultural effect alone but the cost as well. I have the strong feeling that forestry training in this country, to date, in this important particular has fallen below the European model which was supposed to be our pattern; and this in a country devoted more than others to present returns and tangible results seems to me a very great limitation.

I could present numerous examples from widely scattered fields to illustrate my meaning. I will, however, confine myself in this direction to citing one example and putting one question.

First, can anyone point to a case where a forest-owner has purposely and consistently practiced conservative cutting where logging by railroad was employed?

Second, last fall I had the privilege in the Service Building of looking over a considerable number of technical men's reports on timber sales. I was particularly struck for one thing with the considerations referred to as affecting the plan of marking. These with one exception were of a purely silvicultural nature. Only one man out of the lot, as far as his report showed, recognized the fact that the plan of marking might influence the cost of logging and so affect stumpage, or that taking the grown timber out might have an effect on the small growth then standing and, even if planned and carried out in certain ways, defeat his whole silvicultural scheme. I have no doubt the case was much better than showed on the face of it. I know many of the men in the West and have too much respect for their clear-headedness to believe that they will long or generally overlook essential things.

Early last winter, when asked to read a paper before the Society, I chose as my subject " The Influence of Lumbering upon Forestry." I realize fully that what has been written is not appropriate to that title and can only say that at the present writing it is impossible for me to develop that subject in an orderly or satisfactory way. The gist of what I would say, however, may perhaps be inferred from what has been written. It seems to me that in the present circumstances the lumbermen of the country have quite as much to teach foresters as the other way round. Further, while men may usefully serve in various capacities, according to my view no man can be an efficient practitioner of the profession of forestry who does not combine the qualifications of both sets of men. Some may say that lumbering in many circumstances is a simple affair, requiring little or no training. So, I would answer, are oftentimes the silvicultural principles that can in any case be applied.

For the remainder of this paper I will try to discuss a question that should be of interest to all foresters on general principles, though it may be far from the line of work of some. That is the question how far and under what circumstances the principles of forestry recommend themselves for adoption on lands owned by individuals and business concerns. We have had a good deal of experience on this line in the last ten years with varying results, and it seems as if some reasonably clear inferences ought to result from its consideration. Very likely other men have already carefully considered the same thing.

A good deal turns here on our definition of forestry. If it includes, as it seems to me it certainly should, first-class economy in the utilization of timber resources and cheapest and most effective operation of the same, it is clear that the forest-owner wants it and can really afford to have nothing less. In fact, my idea of the way in which foresters will gain their footing in business and win positions of command therein is through service in just that field. Land surveying, map-making, inspection of cutting, laying out roads and railroads are things which foresters can soon learn to do better than anybody else, and they are all matters which affect profit and the solvency of business concerns. These things as actualities ought to be identified with the name of forestry, and the presence of a forester in a business should be a guarantee that in these important matters it is thoroughly sound. This much men properly trained can quickly furnish, and when it is in hand their standing will be secure and their judgment trusted. They will not have to recommend or beg for whatever is practicable in the way of protection or reproduction.

There is, however, another and more difficult matter here —the relation to business and investment on the financial side. There are two interests here to be considered—that of the owner of woodland and that of protection, growth, and reproduction on the land. The questions arise: How far are the two interests identical? Where and why do they clash? How can they best be adapted to one another?

The answer to these questions is not simple and foregone. In my opinion the man who thinks forestry and business can never and nowhere be harmonized is just as much in error as the optimist who thinks they always can. At first glance indeed the problem looks difficult.

We have been well schooled in the past on the length of time it takes to grow timber—anywhere from fifty to one hundred and fifty years. On the other hand it has been often pointed out that the American business man has but a short range of view, looking generally to the amassing of a fortune during the course of a business life. This is largely true and at first glance the two interests seem irreconcilable, but when we look closely hopeful signs and ameliorating circumstances are found that greatly modify the case.

Within the home field of the writer the best illustration of what is meant is found in the paper mill. Paper-making is one of the great, profitable, and growing industries of the northeastern section of the country, and one that is dependent on the forest for its raw material.

A great feature in the business is the comparative costliness of the plant. A mill plant which consumes seven millions of spruce a year, and which, carrying the wood through the stages of mechanical pulp and sulphite fiber, turns out fifty tons of paper a day, costs not far from $1,000,000; and that investment is mainly in a fixed form, one that can not be abandoned without loss if timber supplies run out. An assured supply of wood is essential to the safety of the investment, and that as a final dependence when native supplies are gone can be secured only through growth. Of course we know that resources are great; we know, too, of the reliance placed on the great stocks north of our borders in Canada; but good forestry on our own lands already has a pointed interest in this connection, and sooner or later it will be the main reliance. Everything in this field is working toward forestry. The great business forces are driving full in our direction. The paper mill with its own forest backing, and this handled in the most careful fashion for the general safety and profit of the business, looks like the form under which a large section of the eastern forests will be permanently held.

Another illustration is afforded by a great timberland estate, consisting of many hundred thousand acres, scattered across much of the width of northern Maine. This property was built up during the lifetime of one very able and active man, but in recent years has fallen to others of different temperament. These men believe in growing timber-land and are glad to retain their investment in that form as far as may be done. Consequently they are alert in the matter of protection and are practicing conservative cutting in the best form they know.

These instances illustrate a fact that is doubtless true in other localities and in many relations. It is that in the field where business and the woods touch one another, financial conditions are frequently right for forestry, that indeed landowners in some cases are now reaching out for it and seeking the best guidance they can find. The men in actual control of that work would seem to be in their field the real foresters. Old woodsmen are doing it for the most part now because they are known and because at their hands owners feel safe from blunders, but technically trained men can get the work to do when it is clear that they can do it any better.

It should be clearly realized also that forestry is very often perfectly sound on the financial side and yet, for some reason entirely independent of that fact, its interests are disregarded. An excellent illustration is the following:

A business man of the writer's acquaintance had a piece of thrifty fir and spruce timber, well located in every way, which he was cutting to the lowest practicable limit. The good policy of cutting on the piece was not disputed, but it seemed to be a pity to sacrifice the smaller and more rapid-growing stuff, and in consequence a little study of growth was made, with the idea of showing the owner where his interests lay. This study showed in the first place that the small fir, from eight to twelve inches in diameter, breast-high, which constituted a large share of the stand in question, was growing in merchantable contents at the rate of about ten per cent. a year; and secondly that sticks four inches in diameter at sixteen feet above the ground, which was the lowest merchantable limit,—sticks, that is to say, which cost all they were worth to get them to the mill,—were worth to grow, liberal discounts being made for risks taken upon them, no less than five cents, or one-third of an hour's time for common labor. This last was obtained by taking the stumpage value of a stick when it would scale one hundred feet, and discounting back at five per cent. compound interest for the number of years required by a tree four inches in diameter sixteen feet from the ground to reach that size. Two inferences were drawn from these results, and it would hardly seem possible to dispute them,—first, that the smaller merchantable timber on that ground was very handsome property to hold for income, and second, that the value of the smaller trees justified the exercise of great care in the logging. The proposition was safeguarded too. Everyone concerned knew that there was very little to be feared either from fire or wind.

Here, if ever, was a case where the interests of forestry seemed to go hand in hand with those of business. But that, as a matter of fact, was not the way in which the owner viewed it. Notes coming due were the big feature in his horizon, and no matter what it cost him in the way of profitable assets, he had to have ready money to meet them. So he not only cut his timber clean but he let out the work without restriction to the man who would do it cheapest. To stop ten per cent. income in order to extinguish five per cent. indebtedness, may or may not be good business management, but that at any rate is the action into which some men's excess of enterprise frequently leads them.

The second-growth pine lands of New England illustrate all sides of the matter. A good deal has lately been learned about them in a scientific way, but long ago the vital fact was grasped by hundreds of men that these woods are vastly productive, that they are safe, and that they pay a big interest on investment. In fact, great areas of these woods are handled very close to true forestry principles to-day.

But take the case of the men who, as foresters look at it, are on the wrong side of this question; the men who are rushing the cut perhaps to an extent that is beyond the best interests of the country. What is their relation to the matter? If we understand this thoroughly, perhaps it may be possible with the light obtained to introduce a counteracting influence.

The motive of course is financial gain. The portable sawmill man has no interest in the land or its production. His money is made in manufacturing, and his profit is proportioned to the volume of his cut. He knows exactly what he can make out of a piece of timber, and the owner with his less exact knowledge, sometimes in financial necessity, is as putty in his hands. It is not that forestry is not sound here, financially speaking. On the contrary, the owner's interest runs in harmony with the best development of the woods; but there is a party here, a strong and well equipped party, whose interests are all on the side of rapid cutting, and divorced from those of the land. The portable sawmill man buying one lot of timber to turn into cash in order that he may buy another is the clearest type of those men who, as the stock phrase has it, are devastating the country. He is not to be blamed, of course. His business can not be interfered with. The effective remedy against him is that the lands should be in the hands of strong, conservative people, people who know their value and are resolved and able to secure the best returns. That fact constitutes the opportunity of foresters. It is a financial as well as an educational one.

The principle underlying all these illustrations is a very important one and must be carefully limited and guarded. Considerable size in a forest property makes regulated management easier, and consolidation of holdings therefore might be thought to yield a sure prospect of better forest management. That, however, is not a safe inference. Many large firms, owners of great tracts of virgin timber, hold them only for early exploitation. They are that kind of men; their history is all of that nature; their organization is adapted to that end, and the value of cut-over or newly stocked land seems trivial alongside their mature timber. Forestry does not appeal to such men, and anything worthy of the name probably will come about only with the second growth and under state ownership, or after the dispersal of these holdings among owners of entirely different type. Consolidation, too, is sometimes of purely speculative nature, and holds out no promise of the careful employment of resources.

The farmer is sometimes a fairly good forester, and I could point to a number of bodies of land in New England, held by their owners with the backing of small manufacturing enterprises or mills sawing for local demand, that in the past have been handled with care and foresight. These are most profitable to the country in every way, and it is to be expected that as time passes their number will largely increase. Actual dispersal of property into small holdings, however, is by no means a sure indication of better forest management. At any rate the great tracts of permanent forest, which must be the source of the materials of commerce and exportation, never will be handled in that way.

Permanence of ownership is one thing that is generally recognized as telling very clearly in forest condition and management. Almost every new purchaser cuts heavily to reduce capital investment, and that legitimate principle, carried beyond reasonable bounds in the case of those tracts which have been the football of traders and speculators, has wrought havoc with their resources and cut down their growing power.

The type of forest and the methods of operation determined by its topography often go far to settle the question of policy. The factors that tell here are too numerous to be dealt with, and I must be satisfied with a single illustration. Thus in Northern New England abundance of drivable water makes frequent and moderate operations profitable, and through that means a condition has been brought about in the natural course of affairs very favorable to growth and reproduction. On the other hand, when no such streams were available, the land when it was reached has been subject to a very thorough and heavy cut and reproduction put at all possible disadvantage.

The mere fact of residence in the locality where his investment lies seems often to determine the attitude of the owner toward his property. Men who expect always to live in a community naturally develop an interest in its permanent prosperity and the conservation of its resources, whereas the outsider with no such interest may have in view only the quick accumulation of profits to be taken out of the country for investment or expenditure elsewhere. Regions could be named where this fact seems to control the whole organization and method of business, where too the former type of management, side by side with the other, is proving itself actually more profitable in every point of view.

In Europe the family instinct has allied itself with forestry and found in forest investments an excellent means of perpetuating family dominance and wealth. So far in this country no movement in that direction is perceptible. More promising perhaps in our conditions is the corporate form of ownership which extends the outlook of the owner and which, affording at the center of management a field for active and enterprising men, allows a share at least of the financial load to be turned over to the general investor with his willingness to accept a small, if regular and secure, income. I have great hopes of the development of this idea in the near future. At any rate, the way will be open for many a profitable and conservative enterprise when foresters have secured the confidence of the investing public.

Looking more broadly, however, at business as based on the forest, we may observe a general and perfectly natural movement that tends progressively to harmonize the owner's interests with those of foresighted management. It is a change in the type of owners and operators, involving a willingness to make large investments and accept smaller pro-rata returns. In former times a trade in timber lands was not thought a good one unless the purchaser could pay for the land by the first year's operation. In buying property to-day the purchaser looks forward frequently to costly development and deferred returns. Forest properties have multiplied in value not alone because of increased stumpage values, but because of the abundance of capital on which men were glad to accept smaller returns. Timberland properties have been looked on latterly not altogether as a stand for doing business but more and more as a form of invested capital, with the feeling and the desire for permanence which that fact gives. That movement of the past is growing in dimensions and force. It is one which calls more and more for management directed toward yield in the long run, which is the root of the forestry idea. It is a movement which must in the nature of the case go on until the returns from forest investments reach the level of those from every other line of investment that is equally stable and secure.

I have been endeavoring in these last pages to point out the financial and other circumstances which make it possible or desirable for the owner of forest property to adopt those principles of management which we look on as embodying good forestry. I dare say that the impression left is far from clear, and I will therefore endeavor in closing to restate briefly a few main points.

First, old-time lumbermen and lumber firms are in large measure hopeless. They are so accustomed to enormous returns and to doing business in a large and also a loose way that the business of forestry looks to them pitifully small.

Second, staple lines of manufacture, using wood where the manufacturing plant is costly, have a heavy interest in permanent forest supplies. On that account they have in some cases invested heavily in forest property and used it in careful fashion. That movement seems likely to increase.

Third, the selection method of management is commonly the first one to be employed in regulated fashion. It would seem also to be the best one in critical circumstances because there is always a stock on the ground to secure reproduction and to furnish a motive for protection. Cheap natural means of transportation, such as drivable streams, are favorable to this as they render a light and frequent cut feasible and profitable.

Fourth, any circumstance such as residence, family considerations or other property interest nearby, which renders an owner's interest in his forest property permanent, disposes him to foresighted management. On the other hand, with dickering, with speculation, with rapid turning of assets forestry can have nothing in common.

Fifth, as the country grows richer and capital looks for a less and less interest return, a condition is being gradually brought about which is more and more favorable to the practice of regulated forestry. Foresters should understand this clearly and endeavor to organize forest ownership in attractive forms.

SILVICAL NOTES ON THE LODGEPOLE PINE

ELMER REED HODSON

Delivered before the Society April 16, 1908

It is well recognized that lodgepole pine is an important species, for it occurs in such dense stands and over such a wide range that it forces itself on the attention. This is particularly true in the Rocky Mountains, where the recent recognition of its economic value has emphasized its importance. In other places, where it is now overshadowed by larger and more valuable species and for the present its real value obscured, it is certain to be appreciated in the future. The history of its utilization will only repeat that of many other so-called inferior species.

When it is realized that over one-half the forests of the Rocky Mountain region are lodgepole pine, and that in many of the ranges it forms practically the whole forest to the exclusion of other species, it is readily seen how important is the proper management of this type of forest. Aside from the value of its timber product a lodgepole pine forest also has high efficiency for watershed protection, ranking next to spruce and balsam in this respect. In comparison with the most valuable western commercial species this pine is of such small size that its full value will only be realized when the supply of the former has been greatly reduced. Its commercial usefulness, therefore, in many places lies in the future.

In case of a species of such importance and so wide a range, the character, abundance, and distribution of its reproduction demand serious consideration and study. In certain instances its reproduction is so marvelous that it is misleading. Lodgepole pine is a tree which is so much better equipped to reproduce itself under adverse conditions than its associates that it is natural to assume that abundant reproduction is certain to follow any cutting or fire. It is believed by many that it will somehow take care of itself. A careful study of the actual conditions, however, leads to the conclusion that such a view is not warranted.

During the past season a study of the amount and condition of its reproduction was made on a number of old cuttings in Montana and Wyoming. The object of this study was to find out the rapidity and effectiveness with which the early cuttings in the lodgepole pine type are being reclothed with reproduction sufficiently dense to insure a future forest of high-grade material. It is one thing to have reproduction, and it is quite another to have enough of it to make straight, clear trees. Especially is this true of a light-demanding species like lodgepole pine.

The old cuttings studied were located in the Helena and Hell Gate National Forests in Montana and in the Big Horn and Medicine Bow Forests in Wyoming. They were of all sizes, shapes, and ages. The largest cutting comprised several thousand acres, while the age of the cuttings varied from a few years to thirty years. In a few cases it was nearly forty years. The average range in age of those examined was from ten to twenty years.

On representative areas of these cuttings sample plots were laid off and the number and age of all seedlings on each determined. Most of the plots were ten feet square, a few were a quarter acre in size. According to the data obtained from these plots the number of seedlings per acre varies from a few hundred to fifty-five thousand. The amount of reproduction per unit area is not strikingly large except in a few cases. There were but fifteen plots, out of the 180 studied, on which the number of seedlings ran over ten thousand per acre. There were only nine plots in the burned cuttings on which the number of seedlings ran over ten thousand to the acre and on only four of these plots did the amount run over fifteen thousand per acre. On cutover unburned land six plots had over ten thousand seedlings to the acre, three of which had over fifteen thousand seedlings to the acre.

The records of these plots include a detailed statement of the important facts which bear on reproduction, such as the forest type, kind, age, shape and size of each cutting, etc. The presence or absence of seed trees was noted and whether fire or grazing had affected the area. It was especially noted whether there had been any change in the surface of the soil or in ground cover due to cutting, and if so what effect it had on the seedlings. After a number of the cuttings had been examined it was found that a density of eight thousand seedlings per acre was required to produce the best stand at maturity. Eight thousand seedlings per acre was, therefore, assumed to be the standard density for full lodgepole pine reproduction in the Rocky Mountains, and all the cuttings afterwards examined were judged by this standard.

In the course of the study the influence of fire was strikingly illustrated. This is one of the most important factors in lodgepole reproduction. It clears away the accumulated undecomposed material and prepares the soil. In addition the heat releases a great deal of seed from sealed cones. It should not be overlooked, however, that the prime service of fire is to prepare a seedbed and not to open the sealed cones and scatter the seed. The majority of lodgepole cones open and discharge the seed soon after ripening without the aid of fire. A light fire, therefore, aids lodgepole reproduction except in certain cases. For instance, if a young stand is burned over before the seed-bearing age or, even in dense stands, after the seed-bearing age, little reproduction follows. In the latter case there is a small amount of seed, but the density of the stand makes the fire so hot that all the seed is destroyed. Where repeated fires follow in rapid succession there is no chance for the young growth to produce seed, and in such cases even light fires may have a disastrous effect on the forest. Contrary to the general supposition that fire is universally beneficial to lodgepole stands, barren land has often been the result of fire in this type. There can hardly be any question that one fire at the right time in this type is beneficial from the standpoint of reproduction in the majority of cases. Fire promises to be invaluable in handling the lodgepole type in the Rocky Mountains, and its careful use can hardly fail to bring good results.

The unfavorable situations are benefited most by a light fire. Moist places usually have considerable reproduction anyway, but the drier places have very little unless fire has run over the ground and prepared a seed bed.

It was found that the size of the cuttings had a great deal to do with their seeding up effectually. The seed of this species is light and provided with large wings, and may travel a considerable distance; but it seldom does so to any great extent. The largest amount of seed falls within a few hundred feet of the seed tree, and the radius of effective reproduction is much less than is commonly supposed.

One of the most interesting facts brought out in our study was the rate at which reproduction on old cuttings comes in. The length of time required for reproduction to cover the cutting area was found by subtracting the age of the seedlings from the age of the cutting. It was found that if reproduction does not come in soon after cutting, it rarely forms dense stands, and may not come in at all. Two or three years after cutting, the seedlings usually begin to come in rapidly. At five years after cutting seventy per cent. have started, and at ten years ninety per cent. The remainder come in very slowly in the following five to ten years. The more rapidly the reproduction starts after cutting the better, for the soil conditions are constantly changing and becoming more unfavorable. In addition, on the large cuttings the amount of seed on the ground is gradually diminished through germination and decay. In such cases the seed supply is not constantly reënforced from nearby seed trees and must in time completely disappear.

Grass is a detriment to young seedlings of lodgepole pine and frequently is abundant in a mature stand. When a stand is opened up by cutting, unless reproduction is favored in some way, the grass takes hold very quickly and forms a sod which to a large extent prevents reproduction. This applies particularly to soils of a limy character and to any other kind of a soil where the situation is less favorable to tree growth than to grass.

The study of reproduction clearly indicates that a selection cutting is not suitable to the lodgepole pine type. Although this system may sometimes be advisable as an expedient, it can not be used successfully for the purpose of getting reproduction. If carried on for any length of time, it results in a steady deterioration of the forest.

Cutting for increased diameter growth with the purpose of coming back in a short time for a second crop, and cutting with the object of getting efficient reproduction, are two distinct things in the lodgepole pine type. Both aims can not be achieved at the same time by a cutting which is really a thinning. When a cutting is made to remove the large-sized mature timber, it may cause increased growth of the middle-sized trees, but in this type reproduction can not be obtained in that way. It must start in the open, and to be effective it must be dense. The fact that selection cuttings always show some reproduction does not mean that this will eventually produce a high-grade stand, since it is very rarely thick enough to clear itself well. This should be clearly recognized.

On a majority of the old cuttings examined during the past season, which included both selection and clear-cut areas, the present reproduction is not at all satisfactory.

Too small a percentage of the cuttings has any reproduction whatever and much of the young growth lacks sufficient density. On all the clear-cut areas examined only about one-half had any reproduction at all. On the other half reproduction was entirely absent. Of the whole area only one-fourth had reproduction of sufficient density to produce a good future stand. This is the real condition of the cut-over areas of a species which has long been considered one of the best to reproduce itself under adverse conditions.

In all schemes of management the effect on reproduction should obviously receive first consideration. Now to secure effective reproduction by natural seeding there is but one thing to do here as well as elsewhere, and that is to follow Nature's method. Fortunately, this method is pretty well indicated for the lodgepole type. For the effective reproduction of lodgepole pine there are required plenty of light, plenty of seed, and a mineral soil. All three of these conditions are obtained when a mature stand is burned over; hence the wonderful reproduction which results. To get similar results we must approximate these conditions. As one measure, large clear cuttings with a few scattered seed trees have been recommended in some cases. On the whole this method is too risky to be practiced on a large scale. A limited clear cutting is, in my opinion, the most suitable for the lodgepole type. The reasons are, that this species is intolerant and its reproduction must start in the open as an even-aged stand. At the same time if the clearings are too large, the sources of seed become too small and far away. A continuous supply of seed is necessary, as there is always danger of fire destroying the young stand before it bears seed. All of these considerations indicate that the strip system is the one best adapted to this species. Therefore the following scheme is proposed for handling pure stands of lodgepole pine in the Rocky Mountains: To clear-cut strips one hundred feet wide alternating with solid uncut strips also one hundred feet wide, with no attempt to thin out the strips left standing or to cross-cut them. All strips should be cut parallel with the slope. In cutting the strips the trees may be felled toward the center, the brush piled in one long windrow and burned. At the same time, the whole strip should be burned over lightly. This burning will remove the accumulated undecayed material and expose a mineral soil, which will insure reproduction from the adjoining solid strips.

By this method only fifty per cent. of the timber is cut at one time on any watershed. The watershed is thus left well protected, while at the same time a reserve of mature timber is well distributed over the whole region. The plan provides a constant and abundant supply of seed on the area and an excellent mineral seed bed. The solid strips should not be cut until the reproduction on the cleared strips has reached the seed-bearing age, which is usually at twenty to forty years of age.

Aside from light, the two things most essential to insure lodgepole pine reproduction are plenty of seed close at hand and a mineral seed bed in good physical condition. This system of cutting secures these conditions. It is not contended that it is a system which is practical in every lodgepole cutting, but that it is the ideal method for handling the type, at least in the Rocky Mountains. It is a standard which should be reached wherever practical considerations will permit. When the type is considered as a whole, the strip system should be kept in mind as the most desirable one, whether it can be carried out in every particular place or not.

The greatest drawback at present to the system proposed is its impracticability in certain cases. In many places it is not possible now to dispose of the small material and cordwood, and therefore in those places clear-cutting in strips can not be carried out. But wherever it can be carried out it is clearly to the best interest of the forest to do so.

In conclusion it may be said that this method, or some similar one in which burning over the ground is a feature, must be used if satisfactory reproduction is to be obtained. This applies only to pure stands. Where a desirable species forms the under-story, selection cutting can be practiced to advantage, but where lodgepole pine reproduction is the only kind which may be hoped for, selection cutting should be abandoned as rapidly as possible.

SOME FOREST PROBLEMS OF THE PRAIRIES OF THE MIDDLE WEST

HUGH POTTER BAKER

Delivered before the Society April 30, 1908

A residence of several years in one of the central prairie States and two seasons spent in studying natural conditions through a belt of prairie country from the Mississippi to the foothills of the Rockies convince me that the problems of prairie forestry are not only intensely interesting but that their early solution will be of vast importance to the future agricultural and commercial development of the entire Middle West.

THE REGION CONSIDERED

To define more clearly the region under consideration, a broad belt of country has been selected lying between the lines of mean annual rainfall of fifteen inches on the west and thirty inches on the east and including all or large parts of the States of Minnesota, North and South Dakota, Iowa, Nebraska, and Kansas. There is no part of the region having sufficient soil, where forest trees can not be grown successfully; but until there is a much greater forest covering than at present it will not be so simple a matter to make trees grow as it is farther east or west, where conditions of rainfall and wind currents are more favorable. There is really considerable similarity in the soils of the entire region and there are no soils, except the acid soils of peat swamps, that are not fitted for the successful commercial production of forest trees.

The entire region, except northeastern Minnesota and the Black Hills country, is essentially treeless, though there are numerous indications that this was not always so. There have been some desultory and incomplete studies of early surface conditions in the region, but not enough data have yet been accumulated to justify definite statements as to any forest cover that may have existed in late geological times or as to the causes for present treelessness. Systematic investigations of peat bogs which exist here and there throughout the region might throw much light on the subject (compare "Investigations in Denmark").* We are, however, safe in believing that the treeless condition is not due to any one cause but to a combination of causes or factors such as annual or periodic fires, wind, lack of precipitation, and fineness of soil.

Opportunities for the Practice of Forestry

This region offers large opportunity for the practice of forestry, with consequent solution of the problems of prairie forestry, for two reasons:

First, the large amount of non-agricultural land existing in the States included in the region. Ordinarily one thinks of this whole section of country as a rich prairie covered with grain and stock farms, and it is an exceedingly rich section. The total area of the six States under consideration is 447,225 square miles. The census of 1900 shows that of this area 237,025 square miles, or 174,736,000 acres, is unimproved and non-agricultural land. It is probable that since 1900 considerable areas have been brought under cultivation, but for some years to come there will be an area larger than that of our National Forests which may be devoted to the growing of forest trees without using an acre of cultivated or improved land. Throughout the northern portion of this section the dairy and fruit industries are developing rapidly, and more and more improved land will be used for grazing and fruit-growing. But should we take only half the amount of non-agricultural land as given by the census of 1900, there would yet be an area of 87,368,000 acres, which is nearly equal in size to Minnesota and Iowa combined. This vast amount of essentially forest land, easily accessible to the great markets of the Middle West and largely without the topographic and climatic difficulties of the forest lands of the Rockies and westward, certainly demands careful consideration in the development of a future and perhaps permanent forest policy for this country towards which we are now feeling our way.

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* The deposits of peat in Denmark, varying in depth from ten to thirty feet, have been formed in hollows or depressions in the northern drift or bowlder formation hereafter to be described. The lowest stratum, two to three feet thick, consists of swamp peat composed chiefly of moss or sphagnum, above which lies another growth of peat, not made up exclusively of aquatic or swamp plants. Around the borders of the bogs, and at various depths in them, lie trunks of trees, especially of the Scotch fir (*Pinus sylvestris*), often three feet in diameter, which must have grown on the margin of the peat-mosses, and have frequently fallen into them. This tree is not now, nor has ever been in historical times, a native of the Danish Islands, and when introduced there has not thriven; yet it was evidently indigenous in the human period, for Steenstrup has

Second, the nearness of good markets. This factor oftens controls the success or failure of large commercial undertakings, especially where initial expenditures are great. Under existing climatic and soil conditions we are learning that it is necessary to use seedlings (and well-developed seedlings) in starting successful commercial plantings on our prairie lands. The initial expenditure in carrying on forestry work which involves planting will therefore be

taken out with his own hands a flint instrument from below a buried trunk of one of these pines. It appears clear that the same Scotch fir was afterwards supplanted by the sessile variety of the common oak, of which many prostrate trunks occur in the peat at higher levels than the pines; and still higher the pedunculated variety of the same oak (*Quercus robur L.*) occurs with the alder, birch (*Betula verrucosa Ehrh.*), and hazel. The oak has now in its turn been almost superseded in Denmark by the common beech. Other trees, such as the white birch (*Betula alba*), characterize the lower part of the bogs, and disappear from the higher; while others, again, like the aspen (*Populus tremula*), occur at all levels, and still flourish in Denmark.—From Lyell, "Antiquity of Man."

great, but the accessibility of the land and nearness of market will make it possible to harvest easily and often and to dispose of all portions of every tree.

WHAT LANDS MAY BE DEVOTED TO FORESTRY

The fence post question, and in many instances the fuel question, are just as vital to the prairie farmer as the tie and coal questions are to our railroads. With the introduction of methods of treating timber at small expense it will rapidly become more profitable to grow as a forest crop the softwood species which may be grown on an exceedingly short rotation. The value of agricultural land generally in the region is too great to justify its use for the commercial production of timber over large areas. It is not a business proposition to devote land in any quantity to tree-growing, which will range in price from $10 to $100 per acre, when there are millions of acres of sand hills and sand barrens which will grow good crops of trees and which may be purchased readily at from fifty cents to $5.00 per acre. Though it will not pay to devote large areas of valuable prairie land to tree-growing, it will pay on farms of one hundred acres or more to plant from one to ten acres of rich land to quick-growing species producing wood durable enough for fence posts or which may be easily and cheaply treated with some preservative. Measurements taken on many groves in this region seem to prove that where good land is planted to the right species and given proper culture, returns comparable with those from grain crops are obtained. With the present constant increase in prices of all sorts of wood material used on the farms of this section, farm-owners are beginning to see that it is a business proposition to grow needed wood supplies right on the farm.

PLANTING PROBLEMS OF THE PRAIRIES

If we relegate the growing of forest trees on a large commercial scale to the essentially waste lands of the region, there is left the vast area of good agricultural land which in the future must and will produce a large part of the posts and repair material needed on the farms. This agricultural region offers two lines of planting problems for consideration:

First, planting from the standpoint of protection. This phase of forestry has been an important one to the dweller on the prairie since settlement first began. Without agitation on the part of those early interested in forestry in this country windbreaks were planted as soon as settlers began pushing out across the prairies. Seeds and cuttings of species native along the waterways were first used because easily accessible and cheap. A little later seeds of eastern species were sent out to the prairies by relatives of the settlers and men like Professor Parry of Davenport, Ia., Professor Henry H. McAfee, who was secretary of the original American Forestry Association organized in Chicago on September 10, 1875, ex-Governor Furnas of Nebraska, Arthur Bryant of Princeton, Ill., and Professor Budd of Iowa, were instrumental in introducing evergreens from both the East and the West. In this way all of the native species and a very large number of exotics have been given trial, and it is safe to say that the problem of the species best adapted to windbreak-planting in this section is pretty thoroughly solved. What we do not know and what seem very important problems to be solved during the next few years are: first, just what influences windbreaks of different species have upon wind currents of varying velocities and upon rapidity of evaporation under differences of temperature and humidity; second, just how far windbreaks of varying heights will produce a calm to the leeward under differences of topography; and third, the influence of the nearness and denseness of windbreaks upon grain and fruit production, plant diseases, and injuries by frost. Our own efficient Weather Service has done a little preliminary work along these lines and we know of the results obtained by M. Becquerel in the Rhone Valley and others; yet the problems above referred to are really unsolved and offer an extremely interesting field to the investigator.

Every year throughout this region soil erosion is causing increased injury to fields and their crops, barren ridges, and bottom lands. Both the increase in price and in the crop-production possibilities of the land are yearly making it more necessary that this serious damage from erosion be prevented. Many land-owners appreciate the seriousness of allowing erosion to continue while others do not, and until all know, there should be a vigorous campaign of education along this one line. Such efforts as have been made to prevent erosion have been unsystematic and temporary. A few desultory studies have been made here and there, but more thorough investigations are needed, with the results so presented that owners of land susceptible to erosion will not allow it to begin; and upon lands where it has begun, effective measures will be carried out to prevent further injury.

Within the limits of this region there are a few areas subject to soil movement by wind and in several instances actual sand dunes are forming. Throughout the country as a whole damage resulting from dune formation and movement is very much larger than ordinarily supposed. As most of the dune areas are adjacent to waterways and large bodies of water, it may be that the actual work of dune reclamation belongs to the War Department (example of work at Erie), but experience abroad as well as in this country has shown conclusively that grass-planting alone as a means of dune reclamation cannot be otherwise than a temporary expedient. If the solution of the dune problems belongs to any scientific bureau of our government, it is to the Forest Service.

Second, planting from the standpoint of production. In the light of experience in other parts of the country and abroad, it is probable that the large areas in this section previously referred to as essentially non-agricultural land, amounting to nearly 90,000,000 acres, can only be effectively and profitably handled from a forestry standpoint by the States or by the National Government. As extensive studies have been made of lands of this class west of the Mississippi, their problems will not be considered here.

There, are, however, many millions of acres of agricultural land which should and will produce over small areas and in small quantities the posts, repair materials, and fuel needed on the farms of the region. The long-continued trial of species for windbreaks has shown to a certain extent the species best adapted to the requirements of farm planting. Recent studies have given considerable data, of greater or less value, concerning growth and something as to soil and moisture requirements of the trees which have so far been successful. There are, however, some interesting problems yet to be solved. One of the most valuable trees for this region, the European larch, is an exotic. There are other exotics which upon thorough trial may prove equally valuable. Those foreigners among our trees which are partial failures, such as the Scotch pine, may upon the introduction of seed from the best trees growing in Europe or by selection here be made very much more profitable. Without doubt breeding and selection, though requiring a long period of time, will improve the hardiness and shape of the hardy catalpa, Russian olive, and mulberry, will fix the thornless form of the honey locust, and produce a straight-growing and thornless form of Osage orange, and last and most important produce a borer-resistant black locust.

Under the severe conditions of winter and summer droughts on our prairies proper culture is extremely important in the successful production of a forest crop. We may profit somewhat by the experience gained in the production of fruit and grain crops by dry-farming, yet as a whole the cultural methods necessary in successful tree-growing are unsolved problems. Those who have been observing results of tree-growing in this great central prairie region will agree that the plantings on the prairies have so far yielded but a fraction of a per cent. of what they would have yielded with proper culture and protection.

The early promiscuous mixed plantings made up of a great variety of species did not prove satisfactory and tree-planters have gradually swung to the opposite extreme and are planting too much in pure stand. Either extreme is far from right with all species under prairie conditions, yet with our present lack of knowledge planters are probably safer in putting out their trees in pure stands than attempting mixtures. There are certain combinations of species usually advised for prairie plantings, and yet we do not know actually what the result will be with these mixtures under the widely varying soil and climatic conditions. We can not give advice for the western country based upon results obtained here in the East. This problem of proper mixture of species demands early solution.

WHO WILL SOLVE THE PROBLEMS?

A consideration of the problems suggested leads directly to the question as to who can best solve them. Whether the National Forest Service should take hold of the matter, or whether the States interested are in a position to begin a series of scientific investigations requiring a long period of years and carry them to a successful completion, are difficult questions to answer. At present the States are not willing to provide sufficient funds for the maintenance of organizations under which such work might be carried out. However, with the example of several eastern States before them, there is a growing sentiment throughout the entire region that the several States interested should carry on work in forestry, in so far as it is confined to their limits.

It seems reasonable that problems which are of vital interest and importance to the whole region should not be left to the separate States but should be solved through the efforts of the National Forest Service. If this is not done, one State through lack of interest or ability may hold back the proper forestal development of all the States interested. Upon whomsoever the responsibility of the solution of these problems falls, it is exceedingly necessary that investigations should begin soon that we may have the knowledge absolutely required successfully to practice forestry over the prairies of our great Middle West in a way consonant with the intelligence and energy of her people.

CONSTITUTION

As Amended to Date

ARTICLE I

NAME

The name of this Society shall be The Society of American Foresters.

ARTICLE II

OBJECT

The object of this Society shall be to further the cause of forestry in America by fostering a spirit of comradeship among foresters; by creating opportunities for a free interchange of views upon forestry and allied subjects; and by disseminating a knowledge of the purpose and achievements of forestry.

ARTICLE III

MEMBERSHIP

Section 1. Members may be Active, Associate, or Honorary.

Sec. 2. Active members shall be professional foresters of achievement, whose field of work lies within the United States or its possessions.

Sec. 3. Associate members shall be chosen from those gentlemen, not professional foresters, who have rendered distinguished service to the cause of American forestry. They may attend all meetings of the Society, may take part in its discussions, but shall not be entitled to vote.

Sec. 4. Honorary members shall be chosen from professional foresters of achievement whose field of work lies outside of the United States and its possessions. They may attend all meetings of the Society, may take part in its discussions, but shall not be entitled to vote.

Sec. 5. Any active member may propose names of candidates for Active, Associate, or Honorary membership. Such names shall be submitted in writing to the Committee on Admissions, which shall report to the Society the names which it approves. Votes upon the names of candidates approved by the Committee on Admissions may be cast either in person or by letter. An adverse vote of one-tenth of the members voting, shall exclude from membership, providing the members voting comprise two-thirds of the Active membership of the Society, and provided that not less than three adverse votes are cast. Each proposal for membership shall be accompanied by a brief biographical sketch, giving the qualifications of the candidate for admission to the Society.

Sec. 6. Charges of conduct unbecoming a member may be preferred by any Active member. Such charges shall be made in writing to the Committee on Admissions, which shall without delay investigate them and report to the Society. A two-thirds vote of the Active members shall be necessary to suspend or expel.

ARTICLE IV

OFFICERS

Section 1. The officers of this Society shall be a President, a Vice-President, a Secretary, and a Treasurer.

Sec. 2. The officers shall be elected, as hereinafter provided in Article V, Section 2, from the Active members by letter-ballot at the first executive meeting of the calendar year, and shall serve one year, or until their successors are elected.

Sec. 3. The President shall preside at the meetings of the Society, shall appoint the committees hereinafter designated, and shall perform all other duties incident to his office.

Sec. 4. In the absence of the President, the Vice-President shall preside at the meetings of the Society.

Sec. 5. The Secretary shall keep the minutes of the Society, shall conduct its correspondence, shall announce its meetings, and shall be custodian of its permanent records.

Sec. 6. The Treasurer shall collect all moneys due the Society and have custody of all moneys received. He shall deposit and expend the latter only in such manner as the Executive Committee shall direct.

ARTICLE V

COMMITTEES

Section 1. The following standing committees, composed of Active members, shall be elected by the Society or appointed by the President, as hereinafter specified, at or as soon as possible after each annual meeting: Executive Committee, Committee on Admissions, Committee on Meetings, and an Editorial Board.

Sec. 2. The Executive Committee shall be elected by letter-ballot, shall consist of five (5) members, and shall choose its own chairman. Three (3) members shall constitute a quorum. This Committee shall control all funds, and shall perform any other executive duties delegated to it by the Society. The Executive Committee, before each annual meeting, shall appoint a Nominating Committee of three (3) Active members of the Society, whose duty it shall be to make not less than two (2) nor more than three (3) nominations for each of the officers, and not less than ten (10) nor more than fifteen (15) nominations for members on the Executive Committee. These nominations shall be submitted to the Active membership of the Society not more than eight (8) nor less than four (4) weeks before the annual meeting. Other nominations, if signed by at least ten (10) members and presented to the Secretary in writing at least four (4) weeks before the annual meeting, shall also be submitted to the membership on the official ballot. The candidate receiving the highest number of votes for each office, and the five (5) candidates receiving the highest number of votes for membership on the Executive Committee, shall be declared elected. The Executive Committee shall have the power to fill any vacancies occurring in their number or in any office.

Sec. 3. The Committee on Admission shall be appointed by the President, shall consist of five (5) members, and shall choose its own chairman. It shall consider all names proposed for membership and shall recommend for election only those candidates who in its judgment are qualified for admission to the Society. It shall forward through the Secretary the names and biographical sketches of such candidates, and any other necessary information, to all Active members, who shall vote upon them either by letter or in person. A vote upon such candidates shall be taken at the first executive meeting after the expiration of one month from the date upon which their names were forwarded to Active members. The names and papers of those whom the Committee does not recommend for election shall be returned to the members by whom they were proposed. Appeal from the Committee on Admissions may be taken to the Society, through the written demand of one-fourth of the Active members, addressed to the President. The Committee on Admissions shall also, as provided in Article III, Section 6, investigate charges preferred against members and report upon them to the Society.

Sec. 4. The Committee on Meetings shall be appointed by the President, shall consist of three (3) members, and shall choose its own chairman. It shall select the speakers, subjects, and dates for the meetings of the Society.

Sec. 5. The Editorial Board shall be appointed by the President, and shall consist of nine (9) members. Within this Board there shall be appointed an Executive Committee, one member of which shall be designated by the President as Editor-in-Chief. The Board shall decide on the regular policy of the publication. The Executive Committee shall consider papers read before the Society, or otherwise submitted to it, shall approve or reject them for publication, and shall transact the business necessary to that end.

ARTICLE VI

MEETINGS

Section 1. The Society shall hold executive meetings and open meetings during such portion of the year as the Committee on Meetings may decide.

Sec. 2. Executive meetings shall be open to members only, and shall be held upon the first Thursday of each month within the period heretofore specified. They shall be for the transacting of business and the discussion of any subject selected by the Committee on Meetings.

Sec. 3. Open Meetings may be attended by members and by guests of the Society, and shall be held weekly within the period heretofore specified, except upon the first Thursday of each month, or when otherwise directed by the Committee on Meetings. The Society may hold such field meetings as the Society or Committee on Meetings may direct.

Sec. 4. Special meetings shall be called only at the direction of the President.

Sec. 5. A quorum shall consist of nine (9) Active members.

Sec. 6. Upon the order of either the Executive Committee or a majority of the Active members present at any meeting, any question shall be submitted to the membership for decision by letter-ballot.

ARTICLE VII

DUES

Section 1. The annual dues of Active members shall be five (5) dollars, payable in advance upon the first day of January. Members elected during the first half of the calendar year shall pay dues for the current year. Members elected during the second half of the calendar year shall pay no dues for the current year.

Sec. 2. Associate and Honorary members shall pay no dues.

ARTICLE VIII

AMENDMENTS

This Constitution may be amended by a three-fourths (¾) vote of the members voting by letter-ballot or in person at any executive meeting of the Society, provided the proposed amendments have been submitted to all Active members at least four (4) weeks in advance.

MEMBERS
OF
THE SOCIETY OF AMERICAN FORESTER
1908

Active Members

Alfred Akerman . . . . Athens, Ga.
A.B. (Harvard, 1903); M.F. (Yale, 1906)
State Forester of Georgia

Edward Tyson Allen . . . . Tacoma, Wash.
Forest Service, U. S. Dept. of Agriculture

Fred Elijah Ames . . . . Portland, Ore.
A.B. (Harvard, 1903); M.F. (Yale, 1906)
Forest Service, U. S. Dept. of Agriculture

William W. Ashe . . . . Washington, D. C.
Forest Service, U. S. Dept. of Agriculture

Philip W. Ayres . . . . Concord, N. H.
Ph.B. (Cornell, 1884); Ph.D. (Johns Hopkins, 1888)
Forester of the Society for the Protection of New Hampshire Forests

Hugh Potter Baker . . . . State College, Penn.
B.S. (Michigan Agricultural College, 1904); M.F. (Yale, 1904)
Professor of Forestry, Penn. State College

William Hector von Bayer . . . . Washington, D. C.
B.A. (Cornell, 1904); M.F. (Yale, 1904)
Forest Service, U. S. Dept. of Agriculture

Raymond Eli Benedict . . . . . . Salt Lake City, Utah
Forest Service, U. S. Dept. of Agriculture

Fred Wilson Besley . . . . Baltimore, Md.
B.A. (Maryland Agricultural College, 1892); M.F. (Yale, 1904)
State Forester of Maryland

Wesley Bradfield . . . . Washington, D. C.
B.A. (Alma College, 1902); M.S.F. (University of Michigan, 1904)
Forest Service, U. S. Dept. of Agriculture

Edward Andrew Braniff . . . . Beaumont, Tex.
M.F. (Yale, 1903)
Forest Service, U. S. Dept. of Agriculture

John Franklin Bruins . . . . Leadville, Colo.
B.A. (Beloit College, 1905)
Forest Service, U. S. Dept. of Agriculture

Ralph Clement Bryant . . . . . . New Haven, Conn.
F.E. (Cornell, 1900)
Instructor in Lumbering, Yale Forest School

Clarence John Buck . . . . Medford, Ore.
B.A. (Williams College, 1903); M.F. (Yale, 1905)
Forest Service, U. S. Dept. of Agriculture

Austin Cary . . . . Cambridge, Mass.
B.A. (Bowdoin, 1887); M.A. (Bowdoin, 1890)
Assistant Professor of Forestry, Harvard University

Edward Edgecombe Carter . . . . Washington, D. C.
A.B. (Bowdoin, 1902); M.F. (Yale, 1904)
Forest Service, U. S. Dept. of Agriculture

George H. Cecil . . . . Washington, D. C.
Forest Service, U. S. Dept. of Agriculture

Charles Sidney Chapman . . . . . . Washington, D. C.
B.Agr. (Connecticut Agricultural College, 1900);
M.F. (Yale, 1902)
Forest Service, U. S. Dept. of Agriculture

Herman Haupt Chapman . . . . New Haven, Conn.
B.S. (Minnesota, 1896); B.A. (Minnesota, 1899);
M.F. (Yale, 1904)
Assistant Professor of Forestry, Yale Forest School

Edward Gheen Cheney . . . St. Anthony Park, Minn.
B.A. (Cornell, 1900)
Assistant Professor of Forestry, University of Minnesota

Alfred Knight Chittenden . . . . Washington, D. C.
Ph.B. (Yale, 1900); M.F. (Yale, 1902)
Forest Service, U. S. Dept. of Agriculture

Earle H. Clapp . . . . Washington, D. C.
A.B. (University of Michigan, 1905)
Forest Service, U. S. Dept. of Agriculture

Judson F. Clark . .. . Vancouver, B. C.
B.S.Agr. (Ontario Agricultural College, 1896)
M.A. (Cornell, 1899); B.Ph. (Cornell, 1901)
Managing Director, Continental Timber Company

Willard Weld Clark . . . . Logan, Utah
F.E. (Cornell, 1902)
Forest Service, U. S. Dept. of Agriculture

George Edward Clement . . . . Bangor, Me.
A.B. (Harvard, 1900); M.F. (Yale, 1902)
Forester of the Great Northern Paper Co.

George Lemon Clothier . . . Agricultural College, Miss.
B.S. (Kansas State Agricultural College 1892); M.S. (Kansas State Agricultural College, 1899); M.F. (Yale, 1903)
Professor, Mississippi Agricultural College

Albert Williams Cooper . . . . . . Lyon Mt., N. Y.
A.B. (Harvard, 1901); M.F. (Yale, 1903)
Superintendent of Woodlands, Delaware & Hudson Company

William T. Cox . . . . Washington, D. C.
B.S.F. (University of Minnesota, 1906)
Forest Service, U. S. Dept. of Agriculture

Carl G. Crawford . . . . Washington, D. C.
B.S. (Ohio Wesleyan University, 1898)
Forest Service, U. S. Dept. of Agriculture

Hugh McCollum Curran . . . . . . Manila, P. I.
B.S. (North Carolina College of Agricultural & Mechanical Arts, 1898)
Bureau of Forestry

Samuel B. Detwiler . . . . St. Anthony Park, Minn.
B.S.F. (University of Minnesota, 1906)
Assistant Professor of Forestry, University of Minnesota

Coert DuBois . . . . San Francisco, Cal.
Forest Service, U. S. Dept. of Agriculture

Frederick Dunlap . . . . Washington, D. C.
F.E. (New York State College of Forestry, Cornell University, 1904)
Forest Service, U. S. Dept. of Agriculture

Harold Benjamin Eastman . . . . Washington, D. C.
M.A. (Bowdoin, 1902); M.F. (Yale, 1904)
Forest Service, U. S. Dept. of Agriculture

Martin Lewis Erickson . . . . . . Portland, Ore.
B.S.A. (S. D. Agricultural College, 1901); M.Agr. (University of Minnesota, 1903);
M.F. (Yale, 1906)
Forest Service, U. S. Dept. of Agriculture

Bernhard Eduard Fernow . . . . Toronto, Ont., Can.
LL.D. (Wisconsin, 1897)
Dean of the Department of Forestry, University of Toronto

James Milton Fetherolf . . . . . Salt Lake City, Utah
B.A. (Muhlenburg College, 1901)
Forest Service, U. S. Dept. of Agriculture

Richard Thornton Fisher . . . . . Cambridge, Mass.
B.A. (Harvard, 1898); M.F. (Yale, 1903)
Assistant Professor of Forestry, Harvard University

John Foley . . . . Washington, D. C.
Consulting Forester

Earl Hazeltine Frothingham . . . . Washington, D. C.
B.A. (University of Michigan, 1904); M.S. (University of Michigan, 1906)
Forest Service, U. S. Dept. of Agriculture

Wesley Johnson Gardner . . . . (Deceased)
A.B. (Harvard, 1900); M.F. (Yale, 1903)

Alfred Gaskill . . . . Trenton, N. J.
State Forester of New Jersey

John Clayton Gifford. . . . . . . Princeton, N. J.
B.S. (Swarthmore, 1890); D.Œc. (Bavaria, 1899)
Consulting Forest Engineer

Henry Solon Graves . . . . New Haven, Conn.
B.A. (Yale, 1892); M.A. (Yale, 1901)
Director, Yale Forest School

William Buckhart Greeley . . . . Washington, D. C.
B.L. (University of California, 1901); M.F. (Yale, 1904)
Forest Service, U. S. Dept. of Agriculture

Edward Merriam Griffith . . . . . . Madison, Wis.
Superintendent of Forests, Dept. of State Forestry

John Dennett Guthrie . . . . Washington, D. C.
Ph.B. (Union College, 1902); M.F. (Yale, 1906)
Forest Service, U. S. Dept. of Agriculture

Harry Munroe Hale . . . . Roseburg, Ore.
Forest Service, U. S. Dept. of Agriculture

William Logan Hall . . . . . . Washington, D. C.
B.S. (Kansas State Agricultural College, 1898); M.S. (Kansas State Agricultural College, 1899)
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John Henry Hatton . . . . . . Washington, D. C.
B.S. (South Dakota Agricultural College, 1901)
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Austin Foster Hawes . . . . . . New Haven, Conn.
B.A. (Tufts, 1901); M.F. (Yale, 1903)
State Forester of Connecticut

Ralph Chipman Hawley . . . . New Haven, Conn.
B.A. (Amherst, 1904); M.F. (Yale, 1904)
Instructor in Forestry, Yale Forest School

Cary Leroy Hill . . . . Washington, D. C.
B.A. (University of Michigan, 1901); M.S. (University of Michigan, 1905)
Forest Service, U. S. Dept. of Agriculture

William Churchill Hodge, Jr. . . . San Francisco, Cal.
B.A. (Yale, 1899); M.F. (Yale, 1902)
Forest Service, U. S. Dept. of Agriculture

Elmer Reed Hodson . . . . . . Washington, D. C.
B.S.C. (Iowa State College, 1898); M.S.C. (Iowa State College, 1900)
Forest Service, U. S. Dept. of Agriculture

John Simcox Holmes . . . . . . Washington, D. C.
(Yale, 1905)
Forest Service, U. S. Dept. of Agriculture

G. Morris Homans . . . . . . Washington, D. C.
Forest Service, U. S. Dept. of Agriculture

Ralph Sheldon Hosmer . . . . Honolulu, T. H.
B.A.S. (Harvard, 1894); M.F. (Yale, 1902)
Superintendent of Forestry, Bureau of Agriculture and Forestry

William Fairchild Hubbard . . . . (Deceased)
Sc.Pol.D. (Tübingen, 1902)

Richard Perry Imes . . . . Washington, D. C.
Forest Service, U. S. Dept. of Agriculture

John E. Keach . . . . Saratoga, Wyo.
B.A. (Yale, 1900)
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Royal Shaw Kellogg . . . . Washington, D. C.
B.S. (Kansas State Agricultural College, 1896); M.S. (Kansas State Agricultural College, 1899)
Forest Service, U. S. Dept. of Agriculture

David Golden Kinney . . . . Missoula, Mont.
A.B. (Harvard, 1901)
Forest Service, U. S. Dept. of Agriculture

A. Knechtel . . . . Albany, N. Y.
B.S. (Michigan Agricultural College); F.E. (New York State College of Forestry)

Elers Koch . . . . Missoula, Mont.
B.S. (Montana State College, 1901); M.F. (Yale, 1903)
Forest Service, U. S. Dept. of Agriculture

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B.A. (University of Michigan, 1901); M.S. (University of Michigan, 1904)
Forest Service, U. S. Dept. of Agriculture

Gerard B. Lull . . . . Sacramento, Cal.
F.E. (Cornell, 1904)
State Forester of California

Charles A. Lyford . . . . . . Huttonsville, W. Va.
F.E. (Cornell, 1904)
Forester, Eastern Lumber Company

Louis A. Margolin . . . . Washington, D. C.
F.E. (Cornell University, 1904); B.S.F. (Lawrence Scientific School of Harvard University, 1904)
Forest Service, U. S. Dept. of Agriculture

Roy Leon Marston . . . . Skowhegan, Me.
B.A. (Bowdoin, 1899); M.F. (Yale, 1902)
Consulting Forester

William Herbert Mast . . . . Halsey, Nebr.
B.Agr. (Iowa State College, 1900); M.F. (Yale, 1906)
Forest Service, U. S. Dept. of Agriculture

Wilbur R. Mattoon . . . . . Albuquerque, N. Mex.
B.A. (Wesleyan University, 1895); M.F. (Yale, 1904)
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Clayton Dissinger Mell . . . . . Washington, D. C.
M.E. (First Pennsylvania State School, 1896); B.A. (Franklin and Marshall College, 1902); M.F. (Yale, 1905)
Forest Service, U. S. Dept. of Agriculture

Hamilton Griswold Merrill . . . Santa Barbara, Calif.
B.A. (Amherst College, 1900); M.F. (Yale, 1904)
Forest Service, U. S. Dept. of Agriculture

Francis Garner Miller . . . . Seattle, Wash.
Ph.B. (Iowa, 1900); B.S. (Iowa State College of Agricultural and Mechanical Arts, 1901); M.F. (Yale, 1903)
Professor of Forestry, University of Washington

Louis Christian Miller . . . . . Washington, D. C.
B.S. (Oklahoma Agricultural and Mechanical College, 1900)
Forest Service, U. S. Dept. of Agriculture

Sidney Luard Moore . . . . Denver, Colo.
B.A. (Princeton, 1904); M.F. (Yale, 1906)
Forest Service, U. S. Dept. of Agriculture

Fred W. Morrell . . . . Denver, Colo.
B.S. (Nebraska State University, 1902)
Forest Service, U. S. Dept. of Agriculture

Walter Mulford . . . . Ann Arbor, Mich.
B.S.A. (Cornell, 1899); F.E. (Cornell, 1901)
Assistant Professor of Forestry, University of Michigan

Harry Camble Neel . . . . Denver, Colo.
B.S. (Pennsylvania State College, 1903); M.F. (Yale, 1905)
Forest Service, U. S. Dept. of Agriculture

John Marburg Nelson, Jr. . . . . . Washington, D. C.
B.A. (Johns Hopkins, 1903); M.F. (Yale, 1905)
Forest Service, U. S. Dept. of Agriculture

Frederick Erskine Olmstead . . . . San Francisco, Cal.
Ph.B. (Yale, 1894)
Forest Service, U. S. Dept. of Agriculture

Andrew Edward Oman . . . . . . Washington, D. C.
B.S. (Kansas State Agricultural College, 1900);
M.F. (Yale, 1906)
Forest Service, U. S. Dept. of Agriculture

Allan B. Patterson . . . . Washington, D. C.
B.S. (Dartmouth, 1898)
Forest Service, U. S. Dept. of Agriculture

George Wilcox Peavy . . . . . . Washington, D. C.
M.S. and M.F. (University of Michigan, 1904)
Forest Service, U. S. Dept. of Agriculture

Allen Steele Peck . . . . Washington, D. C.
Ph.B. (Union College, 1903)
Forest Service, U. S. Dept. of Agriculture

James Girvin Peters . . . . . . Washington, D. C.
A.B. (Johns Hopkins, 1900); M.F. (Yale, 1903)
Forest Service, U. S. Dept. of Agriculture

Clifford Robert Pettis . . . . Albany, N. Y.
F.E. (Cornell, 1901)
State Forester, Forest, Fish and Game Commission of the State of New York

F. J. Phillips . . . . Lincoln, Nebr.
B.S. (Michigan Agricultural Colege, 1904); M.S. (Michigan Agricultural College, 1906)
Professor of Forestry, University of Nebraska

Gifford Pinchot . . . . Washington, D. C.
B.A. (Yale, 1889); M.A. (Yale, 1901)
Forester, U. S. Dept. of Agriculture

Fred Gordon Plummer . . . . . Washington, D. C.
Forest Service, U. S. Dept. of Agriculture

Merritt Berry Pratt . . . . . . Nevada City, Cal.
B.S. (University of Chicago, 1903); M.F. (Yale, 1905)
Forest Service, U. S. Dept. of Agriculture

Overton Westfeldt Price . . . . . Washington, D. C.
B.A. (University of Virginia)
Associate Forester, U. S. Dept. of Agriculture

Arthur Bernard Recknagel . . . . Washington, D. C.
B.A. (Yale, 1904); M.F. (Yale, 1906)
Forest Service, U. S. Dept. of Agriculture

Samuel J. Record . . . . Washingon, D. C.
A.B. (Wabash College, 1903)
Forest Service, U. S. Dept. of Agriculture

Paul G. Redington . . . . Missoula, Mont.
B.A. (Dartmouth, 1900); M.F. (Yale, 1904)
Forest Service, U. S. Dept. of Agriculture

Franklin Weld Reed . . . . . Salt Lake City, Utah
Forest Service, U. S. Dept. of Agriculture

Smith Riley . . . . Denver, Colo.
Forest Service, U. S. Dept. of Agriculture

Arthur Cuming Ringland . . . . . Washington, D. C.
(Yale, 1905)
Forest Service, U. S. Dept. of Agriculture

Filibert Roth . . . . Ann Arbor, Mich.
B.S. (Michigan, 1890)
Professor of Forestry, University of Michigan

Douglas Rodman . . . . Washington, D. C.
Forest Service, U. S. Dept. of Agriculture

Max Rothkugel . . . . Washington, D. C.
(Eulenberg Forest School, 1894)
Forest Service, U. S. Dept. of Agriculture

Joseph Trimble Rothrock . . . . . Philadelphia, Pa.
B.S. (Harvard, 1864); M.D. (Pennsylvania, 1867)

Carl Alwin Schenck . . . . Biltmore, N. C.
Ph.D. (Giessen, 1895)
Forester, Biltmore Estate

Charles A. Scott . . . . Ames, Iowa
B.S. (Kansas State Agricultural College, 1901)
Professor of Forestry

George Frederick Schwarz . . . . . Boston, Mass.
Consulting Forester, Hemenway Chambers,
Hemenway Street

William Forsythe Sherfesee . . . . . Washington, D. C.
B.A. (College of Charleston, 1903); M.F. (Yale, 1905)
Forest Service, U. S. Dept. of Agriculture

Thomas Herrick Sherrard . . . . . Portland, Ore.
B.A. (Yale, 1897)
Forest Service, U. S. Dept. of Agriculture

Charles Howard Shinn . . . . . . Northfork, Cal.
Forest Service, U. S. Dept. of Agriculture

Eric Otto Siecke . . . . Pullman, Wash.
B.A. (University of Nebraska, 1904); B.S. (University of Nebraska, 1905)
Professor of Forestry, Washington State Agricultural College

Ferdinand Augustus Silcox . . . . . Missoula, Mont.
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There was issued only one number of Volume III. The next number is Volume IV, No. 1.

Vol. IV No. [illegible]

Proceedings
of
The Society of American Foresters

❧

1909.

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PROCEEDINGS

OF

THE SOCIETY OF AMERICAN FORESTERS

Vol. IV. 1909 No. 1

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WASHINGTON, D. C.
PUBLISHED BY THE SOCIETY
1909

Yale Publishing Association
(Incorporated)
New Haven, Conn.

Program of Meetings

August, 1908, to March, 1909.

October 29, 1908. Open Meeting. Paper by Arthur Bernard Recknagel. The New Reconnaissance—Working Plans that Work.

November 5. Open Meeting. Paper by Ernest Albert Sterling. Forestry for Railroads.

November 19. Open Meeting. Papers by the Following Members:
Elmer Reed Hodson—Engelmann Spruce in the Rocky Mountains.
Samuel Trask Dana—Experiment Stations on the National Forests.

December 17. Open Meeting. Paper by Professor F. E. Clements. Plant Formations and Forest Types.

January 12, 1909. Open Meeting. Papers by the Following Members:
Professor Gordon E. Tower—A Study of the Reproductive Characteristics of Lodgepole Pine.
Clifford Robert Pettis — Problems in Nursery Practice.

January 21. Open Meeting. Paper by Frederick Haynes Newell. The Reclamation Service and Its Relation to Forestry.

February 4. Open Meeting. Papers by the Following Members:
- Karl W. Woodward—Trametes Pini.
- Dr. J. T. Rothrock—Relation between State and Private Forestry in Pennsylvania.

February 18. Annual Meeting.

PROCEEDINGS
OF
THE SOCIETY OF AMERICAN FORESTERS

The publications of the Society are sent gratuitously to all members. Copies of the Proceedings may be obtained from the Secretary for 50 cents each number.

VOL. IV 1909 NO. 1

THE NEW RECONNAISSANCE—WORKING PLANS THAT WORK

ARTHUR BERNARD RECKNAGEL

Presented before the Society October 29, 1908

For a long time there have been sporadic efforts to reduce the technical work on the National Forests to a systematic basis. Especially in the conduct of timber sales has the need of a clearly outlined policy been felt acutely. Indeed, it is no exaggeration to say that in many cases during the press of work sales of timber were made in a decidedly haphazard manner, owing to the inadequate means of telling whether or not the sale was really desirable in its broader relations to the best management of the timber resources in the particular forest and region. This " hand to mouth " method of doing business was universally deplored but was really unavoidable, since the entire energy of the field force was at first necessarily devoted to establishing administration.

Despite the press of work, no one, however, lost sight of the fact that ultimately all sales must be made under a carefully prepared plan of management. As early as October 20, 1905, this policy was officially enunciated:

"It is the purpose of the Forest Service to prepare, as rapidly as practicable, permanent working plans for the more important timbered areas in the forest reserves (National Forests). In order to locate such working plans to the utmost advantage, it is necessary at the outset to select the bodies of reserve timber in which lumbering is most likely to develop rapidly within the next ten or fifteen years, and where the forest conditions are such as to make cutting silviculturally advisable."

Under this policy Working Plan Inspectors were appointed for different reserves and valuable data accumulated, but the resulting plans were academic rather than strictly practical. Furthermore the work was allowed to lapse owing to the urgency of other projects, and, although even before the time while the reserves were still under the General Land Office some working plans had been made, January 1, 1908, saw the following discouraging status of working plans on the National Forests: (For convenience the Forests have been grouped according to Inspection Districts. Both old and new names are given.)

District I

Bighorn (Big Horn), uncompleted. Kent, 1901.
Kaniksu (Priest River), uncompleted. Benedict, 1901.

District II

Black Hills (Black Hills). Griffith, 1901.
Cheyenne (Medicine Bow), partial. Redington and Clapp, 1906.

District III

Prescott (Prescott). Cohoon, 1903.

District IV

Targhee (Henry's Lake), partial. Peters and Boisen, 1906.

District V

Inyo (Inyo and Sierra (E.)). Eldridge, 1907.

District VI

Chelan (Washington (Chelan)), partial. Rothkugel, 1907.

Besides this work a number of preliminary examinations were made, but the total results were rather discouraging in view of the tremendous area involved and the urgent need of adopting at least a tentative plan of management.

In the reorganization of the Service in the spring of 1907, a section of Reconnaissance was created in the then office of Management, charged with studying "the relation of supply and demand of the timber resources of the National Forests. An important part of this work was to be the location and rough estimating of tracts of timber on the National Forests in advance of actual application . . . also (investigating) the future supply of timber needed for special purposes in different localities."

However, the projects undertaken by this section were almost entirely supply studies of localities and certain species. These studies, although valuable in themselves, did not in any way relieve the need for a systematized management of the timber resources on each forest which would co-ordinate the individual sale, however small, with a uniform, clearly-outlined scheme of management.

To this end the section of Reconnaissance, which had lain dormant during the fall of 1907, was roused from its comatose condition and assigned a task of monumental proportions—nothing less than a compendium of timber sales policy according to the following outline:

OUTLINE OF TIMBER SALES POLICY.

1. Timber Statistics:
    - (a) Total stand on Forest.
    - (b) Amount sold.
    - (c) Time needed to cut over Forest at present rate of sales.
    - (d) Limitation of annual cut.
    - (e) Private timber holdings.
    - (f) Accessibility.
2. Recommendations for restriction or encouragement of sales.
    - (a) What timber should be sold or held according to:
        - (1) Amount of timber.
        - (2) Species of timber and condition of timber.
        - (3) Kind of timber. (Lumber, Mining Timbers, etc.)
        - (4). Location of timber. (See also 2 b.)

        (a) Special market to be encouraged.
        (b) Needs of settlers.
        (c) Needs of near-by communities. (Local needs.)
        (d) Needs of whole State or region.
    (b) Graphic presentation of sale policy:
      (1) Dark green: Ordinary sales desirable.
      (2) Light green: Small local sales only.
      (3) Yellow: Free use only.
      (4) Red: Protection forest.

3. Minimum prices to be obtained:
    (a) By species and materials.
    (b) By areas and indicated subdivisions of the Forest.

4. Conduct of Sales.
    (a) Examination of proposed sale areas.
      (1) Special points which should be included in all reports.
      (2) Need of special work.
    (b) Marking and brush disposal.
      (1) Rules already prepared.
        (a) General—applicable to whole Forest.
        (b) Specific—for certain sales only.
      (2) Special recommendations in regard to marking and brush disposal.
    (c) Logging.
      (1) Special provisions.
      (2) Work on other sales, with bearing on future sales.
    (d) Scaling.
      (1) Methods recommended.
      (2) Results of present methods in use.
    (e) Reproduction and the second crop.
      (1) Silvicultural results of the work on completed sales.
    (f) Miscellaneous points.

The data from all possible sources, especially from the timber sale files and inspection reports, were compiled under each of the headings given in this outline. Extracts and summaries were made from the original papers, and there are still on the shelves in the Reconnaissance office a set of well-worn letter files, numbered 1, 2, 3, 4, etc., in accordance with the outline. Although begun early in December, it was late in March when the work was completed and everything bearing on timber sale policy extracted from the files. Since then all matters of sale policy come to

Reconnaissance to be properly recorded, and thus the data are kept up to date.

As the work progressed, new possibilities and needs presented themselves, but the outline as given above remained essentially unchanged and is in force to-day, a year from its inception, which, as Forest Service history goes, is a surprisingly long time.

Under the heading of "Timber Statistics" the estimates of stand submitted by the various supervisors, in response to letters sent out in June of 1907, were edited and compiled, and thus for the first time fairly reliable estimates, by species, secured for the various National Forests. (This table is posted in the Statistical Atlas.) Although a good beginning was thus made, it was realized that many of the estimates were mere guesses and sorely in need of revision. Therefore on March 14, 1908, a circular letter was sent to all supervisors, requesting them to submit new and, if possible, more detailed estimates not later than February 1, 1909. The replies received thus far are very encouraging and indicate that the new estimates will be a great improvement on the present ones.

Estimates are, however, only the basis of a scheme of management. The next step was to take them in conjunction with the timber sale statistics, and formulate a definite sales policy. For this purpose large sheets were used and the data arranged under the following headings:

- Estimated total amount of timber.
  - Live sawtimber.
  - Dead sawtimber.
  - Live and dead cordwood.
- Amount of timber sold since creation of Forest.
  - Per cent. of estimated total stand.
- Amount of timber sold in fiscal year 1906-7.
  - Per cent. of estimated total stand.
- Amount of timber cut in fiscal year 1906-7.
- Proposed limitation of annual cut.
  - Per cent. of total stand.

Years required to cut over Forest at rate of sales, fiscal year 1906-7.
Price limitations (No. 3 in previous outline).
General sale policy (No. 2b in previous outline).

The results of compiling these figures were nothing short of startling. Overcutting had long been suspected on certain forests, but few realized how serious and numerous were the violations of the basic principle that the amount cut on each forest must keep well within the annual yield. On twenty-one forests over 2 1-2 per cent. of the total stand had already been sold and the demand for timber was constantly increasing. These forests fell in three distinct groups—the Arizona group, with the Prescott and San Francisco Mountains (new Coconino) leading; the Colorado group, comprising chiefly the Medicine Row, Pike, Leadville, and Holy Cross; and the Montana group lead by the Hell Gate (new Deerlodge).

The timber sale policy data were also shown on state maps, in order to have them in graphic form and readily available. A standard, abbreviated legend was adopted showing the total stand on each forest, the percentage sold since the creation of the forest and the past fiscal year, the proposed limitation of annual cut, and the approved minimum stumpage rates. (Maxima stumpage rates obtained were compiled separately and placed in the Statistical Atlas). This enabled a raw recruit in timber sales (and how many have been drilled on that famous parade ground!) to act on a timber sale application with confidence that he was keeping well within prescribed limits. It was as different as is an uncharted sea from one where the navigator is guided by certain definite lights and buoys. Not that the need for individual care and judgment is one whit diminished, but the personal equation which so frequently equals mistakes is obviated since the individual's judgment is directed and made to conform to a standard policy. Thenceforth members of Timber Sales were held responsible for all points regarding policy which arose in connection with correspondence assigned to them, and it is not too much to say that many of them obtained a clearer idea of general policy in handling the timber resources on the National Forests than otherwise would have been the case.

Having condensed the timber sale policy and made it readily available for use in the office, it remained to complete it by data from field officers, and to notify supervisors that a certain policy was to be inaugurated on their forests. Minimum stumpage prices were fixed by correspondence on all forests where a satisfactory schedule was not already in effect.

The next step was another circular letter to all supervisors, dated April 9, 1908, requesting them (at the same time with the revised estimates) to make definite recommendations as to the general timber sale policy to be followed on their respective forests. An outline similar to but simpler than the one given above was inclosed. The keynote was struck in the sentence—" A concise, clear-cut, thoroughly practical plan for regulating the cutting on your forest is urgently needed until such time as a more thorough examination can be made and a more detailed plan prepared." However, it was especially important that these matters be considered from the standpoint of the district or region, and that the policies adopted for the respective forests be standardized by natural groups so as to secure the best and most rational use of the timber resources on the whole group. From their familiarity with local conditions, the chief inspectors in each district were obviously the ones to turn to. About the same time instructions were sent to the six chief inspectors, submitting to them the available data on stumpage prices, estimates, and sale policy, and requesting a full report with suggestions as to any necessary changes in the present prices and policy and with as complete and definite recommendations for their respective districts as possible.

In this way splendid results were secured, and it has been possible to adopt a uniform system of prices and sales policy throughout each district. Extracts from the chief inspectors' report have been sent to all supervisors concerned and thus a very satisfactory *modus vivendi* established which, with annual revision, will suffice until such time as a detailed working plan can be made for each forest.

In place of the large sheets mentioned above, a card system has been adopted. A sample "price card" is as follows:

CROOK

Letter to Sup. Birdno, 7-25-08

	Green		Dead	
Sawlogs	$3.00	per M.	$3.00	per M.
Cordwood	.75	per cd.	.50	per cd.
Fence posts	.05	each	.05	each
Poles, etc.	.01½	lin. ft.	.01½	lin. ft.
Fence stays	.01	each	.01	each

In a similar way the estimates, amounts, and per cents. of total stand sold, and the limitation of annual cut (see outline above) are shown on cards for each forest. Tentatively, at least, the color scheme denoting general sale policy is shown diagrammatically in the upper right hand corner of each card.

I realize that what have been described thus far are not working plans, but merely stepping stones toward the goal of having working plans for each forest. When this consummation is attained the millennium can be proclaimed. Until that time we must get along with technical makeshifts. Indeed, the time is not ripe for the elaborate, intensive European working plan, however much it may appeal to the technical enthusiast. "Corraling" the available policy data is the first step; the next is the making of *working plans that work,* and this is the aim of the present Reconnaissance studies on the National Forests. What is needed is sufficient control so that a definite policy of management can be inaugurated. This will avoid a condition of uncertainty as to policy which is all too prevalent, well illustrated by the case of a large timber sale application on the then San Francisco Mountains which was held in abeyance for several months while memoranda pro and con were being prepared as to the advisability of the sale. No one really knew whether or not the sale should be made because no one knew the relation of supply and demand on this particular forest. In other words, the control was faulty. Like an improvident shopkeeper we had been selling our goods without having an adequate inventory and so could not tell whether or not the stock was getting dangerously low.

In looking over the large field to be covered, two kinds of forests were given the preference. First, those forests on which the timber sale business is large and important and the need of fixing a definite policy urgent, rendering it advisable to detail a large, special party, and to make a complete estimate of all the timber on the forest. Second, those forests or parts of forests where a less intensive study will suffice for the present; projects needing only one technical man, aided by as many rangers as can be spared to help in the work.

For the first class of projects the following outline was adopted and made standard:

OUTLINE FOR WORKING PLANS ON NATIONAL FORESTS

(Reconnaissance)

Part I

Introductory:

Nature and scope of work. Time when done. Personnel. Cost.

General Description:

The area.

- Location.
- Topography.
  - Geology and Soil.
  - Drainage and Streamflow.
- Industries.
  - Agriculture.
  - Grazing.
  - Mining.
  - Lumbering.
- Population, present and future. The labor supply.
  - Status.
- Alienated lands.
  - Railroad (reconveyed, covered by timber contracts, etc.).
  - University and School.
  - Homesteads, mining claims, etc.

Part II

The Forest:

- Division into Blocks (according to watersheds and natural logging units. Show on map of Forest).
- Division into types (according to broad, natural divisions).
- Show on map.
- Distinguish permanent and temporary types.
- Describe the characteristic stand in each type.
- Composition of stand.
- Age of trees.
- Size of trees.
- Condition of trees.
  - Mature or overmature..
  - Presence or absence of young growth.
    - Poles.
    - Saplings.
    - Seedlings.
  - Injury through
    - Fire.
    - Insects.
    - Fungi.
    - Animals.
- Estimated stand of an average acre.

Total estimate for each Block according to types and species and classes of material. Separate live and dead timber. (For detailed estimates by forties see Appendix.) Give also amount which should be cut if timber is sold.

Burns and Cut-Over Areas (in Forest and immediately adjoining. Show on map of Forest).

Describe briefly and give acreage by Blocks, if possible. Are the areas satisfactorily restocked? (For detailed description, time when cut or burnt see Section Descriptions in Appendix.)

Part III

Utilization:

Accessibility of timber. Brief description by Blocks.

By what means and at what probable time in the future will timber be opened up?

Present cost of marketing timber from the area (in detail).

Relative amounts and accessibility of private timber holdings and influence on present and future demand for Forest timber.

Timber which should be sold for the good of the Forest:

Special bodies of overmature timber.

Special bodies of dead timber.

Special bodies of diseased timber.

Special bodies of insect-infested timber.

(Show on Forest map. Give approximate estimate and briefly describe condition and possibilities of early disposal of such timber.)

Part IV

Regulation:

Special needs for timber now and in the future

- By settlers.
- By near-by communities.
- By whole State or region.

On basis of above, show in detail on map of Forest whether

1. Ordinary sales are desirable.
2. Small local sales only.
3. Free use only.
4. Protection (Watershed Protection) Forest.

(Use following colors)

1. Dark green.
2. Light green.
3. Yellow.
4. Red.

Limitation of annual cut.—

On basis of (a) present stand in each Block, (b) the present and future demand for timber, and (c) the time required to make a second cut on a normal acre for each type (see growth tables). Determine the maximum annual cut permissible in each block and for the whole Forest.

Stumpage prices.—

Minimum rates for all species and classes of materials. By Blocks if advisable. Differentiate live and dead timber. (If advisable, recommend a commercial and a non-commercial schedule of prices.)

Part V

Management:

Object of Management. Should aim be to grow saw-timber, tie-timber, mining-timber, or other special classes of material? Silvicultural policy to be pursued. The kind of forest desired.

System of Marking. Special modifications of General Marking Rules recommended.

Brush Disposal. Recommendations.

Fire Protection. Recommendations.

Restriction of Grazing. Recommendations.

Miscellaneous.

Appendix

- Maps and tables.
  - Stand and Type.
    - Block and Type map of Forest.
    - Block and Policy map of Forest.
    - Detailed Township maps.
    - Sectional Reports.
  - Volume and Growth Tables.
  - List of Species.
- Notes on Character and Condition of Range.

A simpler outline was adopted for the second class of Reconnaissance studies since they are less intensive.

OUTLINE

FOR RECONNAISSANCE STUDIES OF NATIONAL FORESTS

(To determine the best way of handling the Timber Resources on each Forest.)

1. Divide the Forest into Blocks—that is according to Watersheds and Natural Logging Units. Show these on the map of the Forest.

(a) Within each Block show (also on map, with different colors):—the various forest types, according to broad, natural divisions which can be easily recognized in the field. Describe briefly the characteristic stand in each type, the age, size, and condition of the trees, whether mature or overmature, the presence or absence of young growth (poles and saplings), and of reproduction (seedlings, etc.). Give the estimated stand of an average acre for each type.

(b) *Total estimate* for each Block, according to types and species.* Differentiate between live and dead, and between saw-timber and cordwood. If timber were sold, what per cent. of the estimated stand could be cut without detriment to the Forest? Area of merchantable timber in each Block.

(c) Burns and cut-over areas in Forest and immediately adjoining. Describe briefly and give acreage. Are the areas satisfactorily restocked? Show areas on map by means of double hatching for burns, single for cut-over lands.

II. Discuss the *accessibility* of the timber in each Block. Whether accessible now or not. By what means it will be opened up and at what probable time in the future. The present cost of marketing timber from the area. The relative amounts and accessibility of private timber holdings and influence on the demand for Forest timber now and in the future.

III. Special bodies of overmature, dead, diseased, or insect-infested *timber which should be sold for the good of the Forest* as soon as possible. Indicate on map used under IV (see below) and give approximate estimate together with brief description and possibility of disposing of such timber.

IV. *Regulation of Sales.* Special needs of Forest timber by settlers, nearby communities, or the whole State or region, now and in the future. In other words: (1) Are ordinary timber sales desirable? (2) Small local sales only? (3) Should the Forest or any certain part of it be restricted to free use, or (4) is it merely a protection (Watershed Protection) Forest? These points may be shown graphically on the Forest map by the following colors. (Use a different map from the one on which the types and burns and cut-over areas are shown.)

For (1)—Dark green.
For (2)—Light green.
For (3)—Yellow.
For (4)—Red.

V. Bearing in mind (a) the present stand, (b) the present and future demand for timber, and (c) the time required to obtain a second cut on sale areas, fix an *approximate limitation of annual cut,* if advisable for each Block. The cut should never exceed the producing capacity of the Forest. A conservative policy is advisable. Recommend definite minimum stumpage prices to be obtained for the different classes of material and species. This should include dead timber. Commercial and non-commercial schedules of prices (if necessary).

*Tabulate estimate in detail by sections (if surveyed) and by watersheds, totaling for each Block.

VI. *Object of Management.*—Should aim be to grow saw-timber, tie-timber, mining-timber, or other special classes of material? Decide this from consideration of present and future demand for varous kinds of timber in various localities. What silvicultural policy should be pursued? What system of marking* is recommended to secure this object?—Selection system, strip system, etc. Marking with view to improving the stand, getting an early second cut, etc.

VII. *Miscellaneous Points* Fire Protection. Restriction of Grazing.

On these lesser projects the time-honored systems of estimating are used, but an entirely new scheme was adopted for getting the estimates on the large-party projects. It was immediately evident that sufficiently rapid progress could not be made by using a strip system, even if the calipering were omitted. An ocular estimate of some sort assures rapid progress, but its efficiency depends on the training and experience of the men making the estimate. Fortunately Mr. Frank Vogel, a lumberman of long experience in the Lake States and in Montana, entered the Service about this time and was put in charge of the estimating work. After considerable consultation and planning a new set of forms was adopted, which closely approximates those in use by the Big Blackfoot Milling and Mining Company of Montana for their extensive timber cruising. In almost all respects this was a radical departure from methods of estimating previously used in the Service.

The field book is of handy size, stoutly bound, and contains enough blanks for one hundred complete sections. In the front is a traverse table to facilitate making offsets in rough country. The rest of the book consists simply of a set of section plats, scale four inches to the mile, ruled for forties; the left-hand side of each double page for sketching the topography and types; the right-hand side for entering opposite the corresponding initials of the species the estimate by forties for saw-timber and cordwood. Across the top of the double page are blanks for the name of the examiner, the date, and the number of the section, township, and range.

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* See General Marking Rules for Forests.

In estimating, the men work two in a crew, running up adjacent tiers of forties, and at the end of each section checking on each other and on the nearest section corner. Where the area is unsurveyed, land lines are merely approximated and watersheds govern.

***Examiner*..................................*Date*................, *19*......**

No attempt is made in the estimating to caliper or to use volume tables. The estimate is entirely ocular and involves good judgment on the part of the cruiser, as he paces through each forty following a compass line. Even with this rough method, I do not believe that any of the estimates will prove to be in error more than 15 per cent.

Sec. .... *T.* .... *R.* ....

Y. P.				
D. F.				
W. F.				
E. S.				
C-d.				
Y. P.				
D. F.				
W. F.				
E. S.				
C-d.				
Y. P.				
D. F.				
W. F.				
E. S.				
C-d.				
Y. P.				
D. F.				
W. F.				
E. S.				
C-d.				

All locations are made by pacing and checking on surveyed corners. Barometric elevations are taken at all important points, and type lines, burns, cut-over areas, and all culture accurately located.

At the close of a day's work the two men who have worked together assemble their data, transferring them from the field book to the section plat, which, in addition to the sectional diagrams for maps and species described above, contains headings for a brief description of the section (to be filled in according to standard instructions). An actual example follows:

San Francisco Mts..............................National Forest
Date...............June 11................1908.
Examiners......................J. H. Allison and Frank Vogel.
Sec......8, T......22 N., R. 4 E., G. & S. R. M.

Totals—Live M. B. M.		Per cent. which should be cut	Dead—M. B. M.
Yellow pine	370	60	
Douglas fir			
White fir			
Engelmann spruce			
Cordwood		100	40

Surface

A rolling southern or western slope over most of the section; the steep eastern slope of a volcanic cone is found on the southern part of the western line. Malpais (volcanic) rock covers and underlies the entire section.

Soil

A shallow to deep loamy clay. It is dry and not liable to erosion. In the northwestern part there is a gravel which erodes easily.

Ground Cover

A light cover of grass and weeds. Range in good condition and no apparent damage by stock.

Species, Size, Quality, and Condition

Yellow Pine

On the uncut part of the section, will average 3½ logs per tree and 6 logs per M. feet, B.M. Timber of good quality and in fair condition. All the merchantable timber has been cut on the cut-over portion, but considerable numbers of "black jack" up to 16 inches D.B.H. are found over most of the cut-over area.

Dead and Down Timber

Scattered as individual trees over the section. Of practically no commercial value except for *cordwood.*

Reproduction, Young Growth, etc.

Seedlings, Saplings, and Poles

There is a fair to good stand of young growth over most of the section that was originally timbered. Seedlings and poles make up the greater part of this young growth. There is an especially fine stand of seedlings and saplings on the NW^4 of the NE^4. The stand of young growth is sufficient to restock the area. The seedlings are gaining on the "park."

Burns

There is an old slash burn in approximately the SW^4 of the SE^4 and the SE^4 of the SW^4.

Streams, Springs, Lakes

There is a large spring in the NW^4 of the NE^4, a well in the NW^4 of the SW^4 and a stream of water (which usually goes dry later in the year) along the lower part of the "draw" which drains the large spring (see map).

Cuttings

All the section except the N^2 of the NW^4 and the E^2 of the NE^4 was cut over in 1903, the cut-over part having been taken up as homestead claims, most of which have been relinquished to the Government.

Logging Condition

Good, the section being nearly level.

Remarks

The NW^4 of the NE^4 and the SW^4 of the NW^4 have not been relinquished to the Government. There are cabins on the NW^4 of the NE^4, the NE^4 of the SW^4, and the SW^4 of the SE^4, but they are in poor condition and will probably collapse in a few years.

An important feature of this form is the heading entitled "Percentage which should be cut," since in making a sale it is vitally important not only to know the total estimated merchantable stand, but the amount which the purchaser should be allowed to remove. This is where the technical work comes in, since no man who is not experienced in marking can properly tell what percentage should be cut. *

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* As a standard guide in marking, General Marking Rules are being issued for the various National Forests according to the Forest Region in which they are situated.

When all the sections in a township have been completed, the map and estimate data are transferred to the Reconnaissance township plat, using two for each township; one for the topographical and type map, the other for the total estimates of all species by forties. The margin is made amply wide for additional notes on the map sheet and for summarizing the estimate by sections on the estimate sheet. A special feature of this form is that it is on fine bond paper, in order that it may be readily blue-printed and a sufficient number of copies made to meet all needs.

When a township is completed, township and section plats are promptly sent to the Washington office where the section plats are copied, the township plats blue-printed, and duplicates sent to the supervisor. In this way all data collected are made immediately available and all future sales and applications can be handled by reference to these data without the need of a new examination and the delay which this invariably involves. (Both section and township plats are standard legal folder size and are filed by townships in the regular filing cases, thus obviating the clumsy, rolled map.)

The first forest to be undertaken according to this plan was the old San Francisco Mountains (new Coconino). The party comprised lumbermen, forest assistants, rangers (permanently detailed until the work is completed), a cook, and a packer, making in all a party of nine or ten men—quite formidable and something like the large parties in the old Bureau of Forestry days.

On only one other group of forests has similar work been begun—the Pike, Leadville, Holy Cross forests in Colorado. (Of the lesser projects several are under way and a couple completed, the Manzano in New Mexico and the Cache in Utah and Idaho.)

Estimates on the Coconino were begun in April of this year, and despite vicissitudes of personnel have progressed rapidly. The quality of the work has been most gratifying. The old San Francisco Mountains (area approximately 1,975,000 acres) and about 125,000 acres on the former Grand Canyon (S), total 2,100,000 acres, will be completed this year. In other words, a total of something like 2,320,000 M. feet B. M. estimated in less than nine months. During September of this year the crew covered 130,000 acres and the quality of the work was better than any heretofore. Mr. Allison, in charge of the party, recently wrote me personally as follows:

" We are moving camp usually twice a week. To give you some idea of how rapidly we are actually covering the ground, we would cover the area estimated by yourself at Challender (one month's work) and that covered by Drake, yourself, and myself around and south of Maine in less than a week, and you will remember that that job south of Maine took all three of us with an assistant apiece two months, besides the time you put in at Challender. The total area covered by all three of us (in two months' work) was not in excess of 20,000 acres, while with this outfit I have run as high as 35,000 acres in one week." In other words, about ten times faster than under the old system!

Volume and growth tables have always rightly been considered an important feature of working plans. They are by no means neglected (see the outline for the final report above), but necessarily subordinated to the more urgent work of estimating. *

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* A recent investigation of available measurements of trees occurring on the National Forests revealed a scarcity of reliable data that was truly startling. Unfortunately men and money are not in most cases available to detail special parties for measurements work, at least not for the present, so Forest officers and technical men detailed to National Forests must be relied on. In order to standardize the data obtained, a new tree measurement form has been prepared in a notebook which will serve for stem analyses, volume studies, stump counts, etc.

Under the proposed reorganization of the Service, the future of Reconnaissance will depend largely on the district officers, who, it is hoped, will prosecute the matter diligently. A good beginning has been made and a number of men trained in the work who can form the nuclei for future parties, so that, on the whole, the outlook is very bright. After long floundering around, and making repeated "strong efforts to standardize the technical work on the National Forests," a rough but practicable system of management has at last been evolved—a system full of defects, it is true, but one which satisfies those who are optimistically content to leave coups and compartments to the future and for the present make working plans which will work.

EXPERIMENT STATIONS ON THE NATIONAL FORESTS

SAMUEL TRASK DANA

Presented before the Society November 19, 1908

Up to this time the Forest Service has been forced by circumstances to devote practically its entire attention to the organization and administration of the National Forests. The necessity for their correct technical management has always been recognized and attempts have been made to develop silvicultural systems for use in timber sales; but that these have been in many cases not wholly satisfactory is evidenced by the frequent changes which have been made in marking rules—sometimes even for the same type in the same general locality—and by the poor forest condition, which is, unfortunately, characteristic of many early cuttings.

These crude and faulty methods were, however, to be expected at the outset and were a necessary accompaniment of the first steps toward the establishment of an American forestry practice. Not only have the practical difficulties of organizing the immense amount of land contained in the National Forests absorbed the greater part of the attention of the Forest Service but it has also been greatly handicapped by the lack of knowledge concerning the characteristics of the great variety of species found in the forests and by the lack of technically trained men available to obtain such knowledge.

The point has now been reached, however, where more exact knowledge is necessary and the crude methods hitherto employed will no longer be satisfactory. The experience of foreign countries has shown that methods of wholly empiric origin, as those in this country, have to be constantly changed, and require many years to attain perfection, if indeed they ever succeed in doing so. Deductive methods in forestry are attractive because they furnish at once a basis on which to work. The results are apt to be unsatisfactory, however, and a long time is required to develop a successful system of management. Inductive methods, on the contrary, although at first sight they may appear to be much slower, really yield more satisfactory results in a relatively shorter time.

Considerable research work in various forest problems has already been done in the United States, but this has been largely characterized by lack of persistence and by failure to consider all of the factors involved, so that no results of importance have been obtained on which absolute dependence can be placed. Carefully conducted experiments on areas protected from interference are needed to establish the silvicultural management of the National Forests on a firm footing. The recognition of this necessity has led to official approval of a plan for the establishment of forest experiment stations, which offer an opportunity of doing intensive work and of obtaining results of value efficiently and economically.

Experiment stations of this sort are by no means an entirely new idea or without precedent, since for some time they have been in successful operation in Germany and other foreign countries. The plan was first proposed by Hundeshagen and von Wedekind in 1826, but did not receive sufficient support at that time and nothing was done. In 1870, however, the first forest experiment station in Europe was established in Baden in connection with the Polytechnikum at Carlsruhe. A number of other German States soon followed this example by instituting main experiment stations in connection with forest schools, with branches in various forest districts. Excellent results are obtained from the extremely scientific work done, and the policy is steadily growing in favor. Austria, France, and Switzerland carry on similar investigations. In India, where the work of forest research has, until recently, been almost entirely neglected, the condition of the forest after fifty years of administration is hardly better than in the United States to-day. The need of more intensive work in technical forestry has very lately been recognized by the Government, however, and an Imperial Forest Research Institute and College has been created at Dehra Dun, with a faculty chosen from the Imperial Forest Service.

In the United States the general plan is to have at least one main station in each of the silvicultural regions of the West, and eventually also in the East in the white pine region, the Appalachian hardwood region, and the southern pine region. Each of these regions has distinct forest problems peculiar to it, and these it will be the duty of the experiment stations to solve. Thus, in the western white pine region of western Montana and northern Idaho, the main problem is the perpetuation of the valuable white pine; in the northern and southern lodgepole pine regions in the Rocky Mountains the treatment of lodgepole pine is of primary importance, while yellow pine, Douglas fir, Engelmann spruce, and alpine fir are important species which enter into and serve to complicate the problem; in the Southwest the reproduction of yellow pine is the great silvicultural problem; in California the problem is to favor sugar pine and yellow pine at the expense of other less valuable competitors; and in Oregon and Washington Douglas fir is the species that claims most attention in management.

The experiment stations will be located on the particular forest that is most typical of the region and that presents, so far as possible, all of the important problems to be found in that region. In a way, the whole forest will serve as the experiment station, although there will, of course, have to be one central headquarters where laboratory, nursery, and other experiments can be carried on, and where all of the work will center. The work will be carried on mainly by experimental areas or sample plots, which will be established wherever the best opportunities present themselves. In this way special timber sale areas, grazing areas, portions of watersheds included in irrigation projects, in fact, any area that is desired, can be utilized for sample plot purposes. Where it is necessary to protect these from interference they will be withdrawn from any form of entry " for administrative purposes." This will make it certain that the plots are not disturbed and that the experiments can be carried on indefinitely, if so desired. The advantage of thus having the plots on government land directly under a technical man, and so located and protected that they can be examined at any time, is particularly evident in view of the rather unfortunate experience the Service has had in the destruction of sample plots on private land by fire, cutting, or neglect on the part of the owners.

The problems that can be taken up at the experiment stations are almost infinite in number. They may be divided into the two general classes of forest problems proper and the indirect influences of the forest. Forest problems proper include both individual tree studies and stand studies. In the case of individual trees one of the first things that the forester desires to know is their silvical characteristics. Hitherto silvical studies have been based almost entirely on observations, usually only for short periods, and frequently with contradictory results. For example, one observer may notice more Engelmann spruce than alpine fir seedlings in a particular stand, and immediately come to the conclusion that Engelmann spruce is more tolerant than alpine fir; another may notice that in some places alpine fir comes in under a forest cover, while Engelmann spruce clings more to the openings, and therefore be equally positive that alpine fir is more tolerant than

Engelmann spruce. One man may visit the yellow pine region during a good seed year and the next season notice the young seedlings making their appearance abundantly in favorable situations, and come out with the statement that yellow pine is a prolific seeder with excellent reproduction; another man may visit the same region two or three years later in a poor seed year and after these seedlings have been killed by drought, frost, or grazing, and come out with the equally positive statement. that yellow pine produces but small quantities of seed and that its reproduction is exceedingly difficult to secure.

Evidently observations of this kind are not conducive to a clear understanding of the habits of the different species nor to their correct management. The experiment stations afford a means of determining points like these beyond dispute and in such a manner that the results can be trustworthy for use in formulating silvicultural methods. Not only will the observer be right on the ground to follow up his observations, but he will be able actually to measure the physical factors affecting tree growth. The light intensity required by different species at different altitudes will be measured by means of photometers, and scales of tolerance will be based on actual and not estimated light requirements. The same is true regarding the demands of different species upon soil and moisture. Reproduction will be similarly studied. The frequency of seed years, the age at which fertile seeds are first borne, the periods of maximum seed production, the relative value of seeds from young blackjacks and old yellow pines, and from healthy and diseased trees,—in fact all of the questions relating to reproduction will be carefully and accurately studied. A few other suggestive experiments along these lines, which may be carried on, are as follows: Introduction of new species; influence of species, situation, and soil on root system and on shape and size of stem and crown; influence of physical factors on strength and quality of wood; frost, winter, and drought hardiness of different species; insects and fungous diseases and their eradication; original vitality of seeds, influence of various methods of storage, and influence of nursery methods on the success of field planting.

Stand studies are largely studies of types,—their origin, composition, development, characteristics, permanency, and methods of management. This, of course, includes methods of improvement thinnings, and reproduction cuttings, together with the preparation of yield tables, which in the future will be more and more needed, and are practically a necessity before the Federal forest policy can become thoroughly settled. Even less attention has previously been given to the study of whole stands than to the study of individual trees, with the result that knowledge concerning their development under different conditions is very scanty. To take the case of lodgepole pine, which has perhaps received as much notice as any other western species, foresters are not yet fully agreed as to the best method of cutting, nor as to the requisite density of reproduction necessary to secure the best stands. Here again permanent experiment areas can in time settle the question beyond dispute.

Reproduction problems, particularly as to the effect of different methods of cutting, and of fire and grazing, are of vital importance, and will be among the first to receive attention. That these questions can be handled better by regularly established experiment stations than in any other way hardly admits of doubt. Similarly, studies of methods of brush disposal, which have previously been carried on without system and without securing definite results, can here be taken up systematically, economically, and, without doubt, more effectively.

One of the most important uses of the experiment stations in connection with these stand studies will be the building up of small model forests, which will exemplify the proper method of management to use in that type of forest, and which may be used as a practical object lesson to show foresters, lumbermen, rangers, and others what may be accomplished by rational methods of forest management. A few concrete illustrations of this kind would be worth much more as a means of practical demonstration than any amount of mere talking and theorizing.

Some of the indirect influences of the forest are of hardly less importance than forest problems proper; for example, the much-discussed relation of forest cover to the water supply in all its phases. The problem of proving satisfactorily the relation which is generally admitted to exist is an extremely difficult one, but one which must be taken up and thoroughly investigated before long. Here, too, regularly established experiment stations offer the best means for carrying out the work, as they also do in the investigation of meteorological problems, such as the effect of the forest on rainfall, temperature, wind velocity, and evaporation.

Only a few of the problems with which the new stations will have to deal have been mentioned, but enough, perhaps, to indicate their scope and the practical importance of the results which they will obtain; for it must constantly be borne in mind that the experiment stations are not created for purely theoretical investigations, but that their aim is to obtain results of immediate practical value. Many of the experiments will, of course, require many years before they can be completed, some perhaps will have to be continued indefinitely, but there are very few from which results of value cannot be obtained at least within a few years.

Since the work of the experiment stations is to be purely investigative in character, they will form a part of the Office of Silvics, and the men in charge of them will report directly to the district forester and not to the supervisor of the particular forest on which they happen to be located. Co-operation with other offices in the Forest Service will be encouraged as much as possible, as well as with other bureaus of the Government, and to a less extent with institutions of learning.

It must not be thought that the experiment stations will at once do away entirely with all other work of the Office of Silvics, or that one station will attempt to cover conditions in the whole district. The central station will merely serve as a headquarters where general experiments and experiments requiring the use of a laboratory or of instruments that cannot readily be carried about may be conducted, and from which the work of sub-stations can also be directed. As the work progresses, other main stations in the district will also doubtless be established, with numerous sub-stations, in order to cover all of the various conditions. Meanwhile, general silvical studies will necessarily have to be carried on as they have been in the past.

The first of the proposed experiment stations was established last summer on the Coconino National Forest, and headquarters were also selected for a second station on the Pike Forest, although this station has not yet been organized. The work is therefore well under way and other stations will doubtless be established during the coming year. These stations seem to offer the best method of laying the solid foundations of an American Forestry practice, and of serving as a practical demonstration ground. They should serve as the center for all investigative work in their region, and should eventually lead to a better appreciation of the indirect benefits of the forest and to a full and exact knowledge of American silviculture.

FORESTRY FOR RAILROADS

ERNEST ALBERT STERLING

Presented before the Society November 5, 1908

In the commercial world the stanchest supporters of forestry should logically be found among the wood-consuming corporations, since they must pay the increased cost which the producers demand on the ground of diminished supplies. The interest manifested by the consumers could be expected to bear a rather direct relation to their consumption, because the greater the consumption the greater should be the economy in providing for a permanent future supply of wood. This situation would be modified to an extent by geographical location with reference to sources of supply, and by the character of the wood demanded. The ideal for corporations would be to keep the price of wood material at a fairly uniform figure, consistent with the cost of production, and eliminate the increasing prices due to a decrease in supply. It has been the contention of the profession that these results would be the fruit of a sound forest policy.

The railroad companies of the United States certainly rank among the larger consumers of wood, and probably use annually a greater quantity of timber and more species and grades than are required in any other line of industry. They should, therefore, be vitally interested in forestry. Just how great the railroad consumption of timber is we do not know. In Bulletin 4 of the old Division of Forestry, under date of 1890, it is stated that the railroads use probably not less than twenty per cent. of the total consumption of timber. This was an estimate based on incomplete data, and we have had nothing better during the twenty-eight years since that time. To be sure, the Government has recently given us data on the number of cross-ties used annually, but ties are only a part of a railroad's timber requirements. Estimates on switch and bridge timbers, piling, car stock, lumber of all kinds, and smaller items, such as handle wood, insulator pins, push poles, etc., are entirely wanting.

Using definite figures for a moment, as the basis for another estimate, we find that the Pennsylvania Railroad lines, east of Pittsburgh and Erie, ordered 115,500,000 board feet of lumber, and approximately 4,000,000 cross-ties during 1907. In round numbers this is in the proportion of twenty-nine feet of lumber to each cross-tie. If other roads maintained the same proportion, and used 100,000,000 cross-ties during 1907, the total consumption of lumber by the railroads of the United States during that year would be 2,900,000,000 feet, exclusive of miscellaneous material, such as shingles, cross-arms, piles, etc., which are not reckoned in board feet. Rounding the above to three billion feet, it gives seven and one-half per cent. as the percentage of railroad consumption to the total cut of 40,000,000,000 feet. Converting the 100,000,000 ties into board feet, on the average basis of 30 board feet to the tie, gives an additional 3,000,000,000 feet, and raises railroad consumption in percentage of total production to fifteen per cent. The unreported and miscellaneous timber items would probably further increase this two to five per cent.; so we may safely assume that the old twenty per cent. estimate is not far wrong.

Whether we accept the estimates as to railroad timber consumption or discard them, the indisputable fact remains that the railroads use annually an enormous amount of wood. With this fact established, it is interesting to consider whether any definite action is being taken to forestall a timber shortage and keep prices down. The more carefully the situation is analyzed the more apparent it becomes that the interest which might logically be expected is not being manifested, and that forestry is not finding general application in connection with railroad management to-day.

The exceptions to the general apathy are found in the attempts which several roads have made to provide for a future tie supply by forest planting. The Louisville and Nashville, the Michigan Central, the Illinois Central, the Big Four, the St. Louis and San Francisco, and the Pennsylvania indulged in sporadic attempts to grow black locust and catalpa. In the effort to get quick results by planting fast-growing species, the fundamental requirements of site were ignored, so that the results have been anything but satisfactory.

In the aggregate there are probably not over 3,000 acres of railroad forest plantations in the country which promise to give adequate returns on the investment. If these plantations produce 400 ties per acre, the 1,200,000 ties would last a system like the New York Central perhaps six months. Forest planting can be made successful, but the fact remains that although important in its place it is at best only a part of a railroad forest policy, and that alone it will not solve the wood problems of the smallest system. The tie and lumber crisis which all roads face is bound to come before any of the trees which could be planted would reach maturity, even if they grew at the fabulous rate claimed by certain non-technical enthusiasts. A rather typical example of misplaced confidence was given by the Norfolk and Western Railroad, when, in a burst of enthusiasm, they cleared a tract of loblolly pine and planted it to catalpa. The result was the loss of a promising second-growth stand of loblolly and a plantation of crooked, sickly-looking catalpa. The Santa Fé are now starting along more rational lines by the systematic planting of eucalyptus in Southern California. Even in this work there are many difficulties to overcome, and the field for eucalyptus planting is limited to the territory controlled by two systems, the Southern Pacific and the Sante Fé. On the whole, it must be admitted that railroad tree-planting, so far done, has not helped greatly to develop the practice of forestry by transportation companies.

Aside from the doubtful progress resulting from planting, there is very little to indicate the immediate adoption of a forest policy by American railroads. The Northern Pacific have for several years frankly stated that their tie supply for the eastern portion of their lines would be exhausted in a comparatively short time. As a result they cooperated with the Federal Government to determine the best course to pursue. Although the report, which seemed to have been worked out along practical lines, has been in their hands for some time, no action whatever has been taken toward carrying out its provisions. The Southern Pacific still owns considerable areas of forest land in Southern Oregon and Northern California, but beyond the exploitation of some of the timber and certain attempts at fire protection, nothing has been done. The Chicago, Milwaukee and St. Paul during the last year or two have purchased large areas of timberland along their new Pacific Coast extension; yet there is little promise that this will be placed under conservative forest management or serve any purpose other than a speculative investment.

The opportunities open to the railroads which already own forest land ought to be sufficient incentive for the application of some plan of forest management, but so far they do not seem to have been; and the fact that such roads do not see fit to manage their holdings on a long-line basis gives little promise that other roads will make the expenditures necessary to procure timberlands as sources of future supply. In this connection it would be natural to expect that the educational campaign which has been in progress for some years would be bearing fruit, particularly since the more recent statements indicate an early exhaustion of timber supplies. Much of this propaganda has been directed toward railroad companies and other wood-consuming corporations. The fact that it has not led to the practice of private forestry in any rational form indicates that something must be fundamentally wrong.

In the earlier days of the work, a serious error was committed in putting forestry on a sentimental rather than on an economic basis. The self-constituted advocates of saving the forests instead of using them found favor neither with the lumbermen nor with the consumers who needed the timber, and the prejudice they aroused has been slow to disappear. When the Government undertook systematic propaganda work, there was a decided change for the better, and marvelous results have been achieved. The " woodsman, spare that tree " sentiment has not been recognized by the technical foresters representing the Government; but unfortunately lecturers bearing the stamp of Government approval have been touring the country and under the good name of forestry have been preaching everything else. The generalities expounded have done little good, and, let us hope, little harm; but at best it is effort wasted, and those needing practical help often have not received it from the lecture platforms.

It is not to be expected that men like civil and mechanical engineers, with technical training and practical experience, can be appealed to with the stock oratory in regard to forest influences, much of which we know has very debatable basis. To declare offhand that planting trees on the Pittsburg or any other enormous watershed will store its flood waters is to make impatient, if not disgusted, those who have studied such conditions for years, and know that impounding reservoirs must play an important part in the solution of the problem. As a result the forest engineer as a class is not considered fraternally by engineers in general.

Keeping in mind, under our subject heading, the needs of the American railroads, how much practical value have they derived from the published mass of forest literature? They have learned that forestry is a good thing which should be helped along, but that it has any relation to operating expenses and the payment of dividends has not been made clear. They have, perhaps, gleaned from various sources that a scarcity of certain grades of timber is imminent, and circulars have given the timber cut, consumption, and prices a year or two after the stated conditions prevailed. And their interest in these facts cannot be great since they are aware of them, having supplied the data themselves. Were the figures analyzed and a discussion of them in relation to railroad wood supplies attempted, transportation officials might have their interest aroused. The Federal laws limit railroad operations rather closely to the transportation business, so general estimates on stand and consumption call for no action. Current prices and the sources of supplies are readily available through the minute records in any purchasing agent's office, and general figures of a year or two previous are of little or no value. It is, perhaps, unavoidable, but it is a fact that the things about forestry which the railroads desire to know the Government has not been prepared to tell them. The point of view is radically different, and the Government man cannot expect to get the railroad manager's viewpoint unless he becomes a railroad man. Railroad forestry is making slow progress, and there are many things to explain it, one of them being that the Government organization for the advancement of forestry is not fitted, and naturally so, to show individual railroads what to do, convince them that it will pay, and tell them why.

Other reasons for the apparent apathy on the part of the railroads are found in the local conditions under which they operate, in their financial conditions, and in the personnel of the management. Western roads operating through a treeless region, where high prices and a long haul are entailed to procure the necessary supplies, should first feel the need of forestry. These same roads, however, may be the least able financially to put a forest policy into effect. The eastern roads, on the other hand, would be better able to finance a policy of timberland purchase and management; yet, since they operate through a natural forest territory, they have been able to procure local supplies of lumber and cross-ties. The Southern railroads have the advantage of very cheap timber products, but in their poor financial condition cannot be expected to give much thought to their future timber supplies.

The personal element also enters strongly into the question of the adoption of a forest policy by a railroad company. It is rarely the case that the head of a big transportation system can find time to consider matters which seem outside of the details of traffic. Such an exception, however, was the late A. J. Cassatt, president of the Pennsylvania Railroad system up to the time of his death. Mr. Cassatt became personally interested in forestry, and, with the foresight which characterized his remarkable activity along all lines, appreciated the need of a forest policy for the system he represented. The inertia which must be overcome where the management is not interested is very great. It is so easy for a board of directors to assume that ties and lumber can be procured indefinitely from the same source as in the past, and there are so many details of recognized importance that a new subject like forestry is slow to find a place. Until an operating official of high standing becomes interested, little can be hoped for, and even then he must be backed by a strong conviction and by very definite plans in order to carry his point.

The possibilities or limitations of the present sources of timber supply for American railroads promise to be one of the potent influences in forcing action. Some of the Western roads are obviously approaching the point where ties and lumber, even with the reduced consumption resulting from preservative treatment, can no longer be procured in quantity save at a greatly increased cost. On the other hand, the Southern roads and those operating in the Lake region are able to fill their requirements at low cost. The Eastern lines occupy an intermediate position as regards the price and supply of wood material. The cost of both ties and lumber in the Middle and New England States has increased materially in the last decade, but it is a question whether this is due as much to the decreased supply as to competition among various wood-consumers. The tie supply in the East is drawn largely from small woodlots, and in many regions the output is as great now as it was twenty years ago. Knowing this, railroad managers are in doubt whether to be alarmed over the general statements that the timber supply will be gone in twenty or thirty years. The farmers' woodlots will probably contime to supply a large number of cross-ties for many years. To ignore the woodlots in estimating the nation's timber supply not only introduces an error into the computations but reduces confidence in the published results.

The preservative treatment of railroad timber, particularly cross-ties, is gaining ground rapidly. Wood preservation, where taken up merely as a means of increasing the life of timber, as in most cases, with no reference to the acquirement and management of timberlands as a source of continued supply for the treating plants, is no more a part of forestry than the placing of a plate or a tie to prevent rail cutting. In a comprehensive railroad forest policy, wood preservation would have an important place in relation to the extent and character of the lands to to be kept under management. The Sante Fé, Southern Pacific, Rock Island, and other roads operating treating plants, take no cognizance of such a relation, and, therefore, are not practicing forestry.

When the railroads produce their own wood supplies, instead of foraging the country through which they pass, they will be helped greatly in the work by the knowledge that wood preservation permits the use of many inferior woods which would be valueless untreated. This very condition, however, is probably checking the advance of railroad forestry to-day. It has opened up new sources of tie supply, reduced the drain on white oak and other high-grade railroad timbers, and seemingly has postponed the time when actual scarcity or high prices will force, as a matter of self-protection, the practice of conservative forest management. The acceptance of such a view is extremely short-sighted. The fact that with treatment cheap, inferior woods can be utilized and made to outlast high-grade material should encourage the acquirement of cheap timberlands. The reduction in consumption resulting from preservative treatment also reduces the amount of timberland necessary to supply a given consumer. The cheaper woods will increase rapidly in value in keeping with the growing demand; yet few wood-consuming corporations are far-sighted enough to see the economy in present-day purchases.

The general advisability of railroad forestry is probably accepted as a fundamental assumption by most professional foresters. We even like to consider it a necessity, but if it were it would be more generally practiced. The truth is that there is an unbridged gap between the theory and sentiment on the subject and the hard economics of railroad management. The railroads are in part to blame, for they have been too slow in taking up the subject from their own point of view. That they have not accepted the views of others is perfectly natural, particularly since no definite solutions of their wood problems have been advanced.

If a system to-day reaches the point where some action is considered necessary, it is a difficult problem to find out just what to do. Without a co-operative investigation the Government is not prepared to render much assistance, and a few months' study by an expert will not give more than a preliminary working basis, because the point of view will not be that of the railroad. Moreover, the co-operative plan is not readily accepted, and many companies would rather do nothing than do it that way. Not only railroad forestry, but private forestry in general, is making little or no progress in the East. That such should be the case is most discouraging, in view of the enthusiasam manifested during the past few years. We have fooled ourselves into the belief that the movement is advancing by leaps and bounds, whereas the only real forestry is on the National Forests. The situation in the East will become critical, and it is time a practical way of helping the private landowner is found. The railroads are open to conviction, the lumbermen are not convinced, and the farmers are indifferent. Planting plans and working plans have largely failed of their purpose, much of the literature lacks definiteness, and the correspondence can cover only part of the field. If there is a solution, it should be found and applied without delay; if there is not, it is time to admit defeat.

If the Forest Service is to help the railroads, it should be able to tell them definitely and concisely what to do, and why. If they are to acquire and manage timberlands, what should they buy, and where, and how much can they afford to pay and achieve their ends? If they are to plant, what species shall be used, how shall they be grown, and what will be the cost and profit, and when realized? If their timber should be treated, what species and processes are best, and what will be the cost and life? To be able to answer such questions in a convincing way will require much more definite knowledge of conditions than the Government now possesses. It will also come nearer to paternalism, but if the attempt to help private forestry is continued it should be along more definite lines, and cover the practical economics of the situation rather than general theories, or not attempted at all.

If the railroads, as representative of the larger wood-using corporations, can be assured of the advisability of practicing forestry, a notable advance will have been made. If they do not find it economy to protect themselves against increasing prices and decreasing supply, the producers and smaller consumers can hardly be expected to take any action.

Aside from all other considerations comes the question of legislation unfavorable to railroads. At present, so far as we know, there are no legislative curbs on the practice of railroad forestry other than the exorbitant tax rates exacted by many States. There is no assurance, however, that the way will remain open. If the commodity clause of the Heyburn Act is unconstitutional because of the exception in the case of lumber, will not the attempt be made to include lumber and thus prevent railroad companies from owning and managing timberland for their own use? In the management of a regulated forest property, a railroad company would desire to use as much of the output for its own use as possible, but there would be minor products, such as bark and cordwood, which should be sold to outside parties. Any restrictions on the disposal of the products from a railroad forest would be unfortunate. The Forest Service is in a position to closely follow all forest legislation, and should use its influence to prevent any action unfavorable to the development of private forestry, whether corporate or otherwise.

The general basis for a railroad forest policy is covered by four main points: (1) The preservative treatment of timber to an extent consistent with its use; (2) The acquirement and management of a sufficient area of timberland to provide for the company's requirements indefinitely; (3) Forest planting where necessary in connection with the management of the timberland, and to utilize the company's waste lands; (4) The employment of a trained forester, with the necessary organization, who should eventually have charge of tie and lumber inspection, forest management and planting, timber preservation, and the landscape gardening work. The lack of definite knowledge in respect to details is greatly retarding the progress of railroad forestry to-day. In order to get started the railroads need help in the form of conclusive data which will show that forestry will fit in with their present commercial activities. With this fact established, they can be expected to work out their own wood problems in their own way.

PROBLEMS IN NURSERY PRACTICE

CLIFFORD ROBERT PETTIS

Delivered before the Society January 12, 1909

Before forestry became a matter of general consideration in this country there were many nurseries which produced a class of stock now known as ornamentals. In the past decade there has developed another class of nurseries established mainly for the purpose of growing trees for forest purposes. The former were conducted in the main by men trained in horticulture or kindred lines. The latter have to a large extent been carried on by men of practical experience, who have had little or no scientific training. American foresters have been forced to a large extent to develop their own scientific system of nursery practice.

There are many principles that we may learn from nursery practice abroad, but European methods are often impractical in application here on account of the high price of our labor. Every new scheme which will reduce the labor in nursery work will make stock cheaper in price, and thereby hasten the reforestation of our otherwise unproductive lands. Commercial nurserymen, or at least a majority of them, are apt to follow set methods, which have been evolved in practice, without any real reason except that such practice gives good results.

The primary consideration is of course success; but the forester wants to go a step further and know what makes for success, as a guarantee that his methods are logical and not a matter of chance.

The largest forest nurseries in this country under scientific management are to be found, I believe, in New York State, under the control of the Forest, Fish and Game Commission. Whatever I may say here to-night will be based upon experience gained in the management of these nurseries.

The first essential is to secure a good seed bed. At first in our Adirondack work we were not successful because our seeds were not uniformly good. We therefore collected our own seeds, and this solved the seed problem. But an entire season had been lost in learning the lesson. The second season we had good seeds and secured excellent germination; but the birds picked off the seeds from the young plants during the early hours of the morning before anyone was around, and there was again a failure. The next plan was to build a wooden box around the seed beds and to cover them with wire netting to exclude the birds. As before, the germination was successful and this time the birds sat and sang on the wires but could not get the seeds. The trees lived a week or two and then began to " damp off." Inasmuch as the " damping off " was increased by close humid conditions, we next built seed boxes with both top and sides of wire, permitting free circulation of the air.

Experience showed that a leaf mulch, designed to aid germination, was not entirely successful, especially in connection with our wire seed-bed boxes. We therefore enclosed the box around the sides by thick paper and filled the openings in the lath cover with loose laths. This made a fairly tight box, retaining moisture, also a hot air chamber with a fairly uniform temperature, which produced even better germination than we secured with a mulch of leaves. The covers could be raised at any time and the progress of germination noted; also there was no injury or loss to seedlings, as occasioned by the removal of mulch. With this type of seed-bed we are at present growing not less than 10,000 seedlings in a bed 4 feet by 12 feet, and have grown 22,000 trees in similar beds. We will work for greater density in seed-bed management just as soon as we can solve the fertilizer problem. The wire boxes are not expensive. They cost us $3.00 per bed, including lath shade, and with proper care can be used for six years without repair. This makes their cost approximately five cents per thousand trees produced.

The best germination is secured by pressing the seeds into the soil, so that they will rest even with the surface of the bed, before covering with soil.

We are working in a very sandy soil, which does not produce very vigorous growth in the seedlings. We fertilize heavily in order to secure more vigorous growth and stronger and more resistant seedlings.

By removing the lath shade, in order to dry out the beds when necessary, we try to prevent the development of the damping-off fungus. If damping off starts to develop we use hot sand and dry powders, but scarcely ever liquids, to check the disease. Recently we have treated the soil before sowing the seeds, in the hope of sterilizing the soil or checking the development of the fungus until the seedlings are old enough to be out of danger. The object is prevention, because the disease, when once started, is almost impossible to check. The soil used to cover the seeds should also be treated or new soil procured from a pit. The covering of the seed beds in winter has been a problem. The same amount of leaf mulch used for successive years did not give uniform results. We found that less covering must be used in winters when there was a deep continuous cover of snow, and that this amount would not be sufficient in an open winter. Some plan to obviate this difficulty had to be found. We noted that a leaf covering during the winters of heavy snow fall produced a heating and moulding of the seedlings. Hence we had to plan to prevent this trouble and at the same time prevent heaving. We have solved this problem by covering the beds with one thickness of burlap placed over about two inches of snow. The burlap prevents the melting of the snow and a thawing of the soil underneath, yet it is so porous that heating or moulding does not occur. It works perfectly and is for us cheaper than leaf covering.

Insect troubles are chiefly confined to attacks of chermes, but we have practically exterminated this from the nursery by using kerosene emulsion. It should be applied as early as possible after the eggs hatch.

Our next difficulty was in overcoming losses in transplanting. We have reduced this loss to a minimum by wetting the soil, when necessary, before planting. If our light sandy soil is sufficiently moist, planting is safe and the roots of the seedlings have an excellent chance to attach themselves to the soil. This is much cheaper than the temporary use of lath shade after transplanting in dry weather.

We find that we can increase the quantity production of the nursery by transplanting the seedlings, when one year old, especially with tap root species. In the Adirondacks we must have very strong stock to succeed on the burned sand plains which we are restocking. Consequently the use of seedlings is simply a waste of money, because they are unable to compete with the bramble growth and seldom survive. We must therefore have strong transplants, and it is a question of economy how to get the best with the least expenditure, and secure the highest nursery production.

Experiments along these lines have been carried on with Scotch pine. We find that one-year-old seedlings transplanted two years are far larger and stronger plants than two-year-old seedlings transplanted one year. The former class are the best for field planting, because they are better developed and can be removed from the nursery and finally planted in the field at a much less cost than can four-year-old transplants. We cannot say that this would prove true for spruce or white pine, but will soon know through further experiments.

The nurseryman must not only raise trees of high quality but he must keep down the cost of production. In New York we use an intensive system of nursery practice, by which we are bringing our soil to high productive capacity. Density in production is not necessarily detrimental, provided each tree has all the soil, light, moisture, and plant food it can economically use. We have carried on a series of experiments in seed-bed work to prove this very point. Scotch pine seed was sown in five different beds of the same size, the amount of seed varying in the beds as follows: Six ounces, seven ounces, eight ounces, nine ounces, ten ounces. When the seedlings were two years old, there were over 10,000 in the bed where eight ounces of seed had been sown, and they were just as good as those in the bed where seven ounces were sown. There were about 1,500 more trees in the eight-ounce than in the seven-ounce bed and the cost of sowing and tending was the same, so that these extra trees had practically not cost us anything except about ten cents for the additional ounce of seed. The bed in which eight ounces of seed were sown produced much better trees than where only six ounces were used. The experiment showed further that more than eight ounces of seed did not seem desirable, because when more seeds were used many of the plants were stunted and suppressed; but the actual production from very dense sowing was fully as good as from the bed where only six ounces of seed were sown. Dense seed beds reduce to a minimum the expense of weeding. Perfect drainage and an equalization of the light is secured by building the bed with a slightly convex surface.

We have also conducted experiments to test the quality of various fertilizers. They were carried on in connection with seedlings rather than with transplants, because young plants show the effect of fertilizers much sooner and more strikingly than older ones; also, because it is cheaper to treat small seed beds than the large transplant beds.

In the Forest Experiment Station at Saranac Inn, which is conducted in co-operation with the Forest Service, a series of soil tests were started in the spring of 1907. The year before it was noticed that there were occasional spots where the seedlings were fully twice as large as elsewhere. A careful examination showed that these seedlings were thoroughly rooted in muck, which was used in fertilizing and which had not been properly worked into the bed. As a soil test one bed four feet wide and twelve feet long was covered with pure muck to a depth of one foot. This bed was sown in equal parts to white pine, Scotch pine, and red spruce. Thirty-six other seed beds were arranged in a rectangular form. One row of six beds was fertilized with a very heavy coat of muck at least six inches thick. To the second set of six beds was applied a medium coat of muck, not less than three inches. The third row was left without fertilizer as a check. The fourth row was covered with three inches of muck mixed with three inches of well rotted barn manure. The fifth row of beds had a three-inch coat of manure. The last row had an application of fully five inches of well-rotted manure. These fertilizers were all worked into the soil and thoroughly mixed, except on the first bed where the muck was applied one foot deep. The seeds sown in the spring of 1908 have produced plants which are now equivalent to two-year-old seedlings. The results are as follows:

Wherever muck was used the seedlings are smaller and have a poorer color than on the check bed, except in the bed where muck was used without soil, and here it compares favorably with the check. The larger the amount of manure used, the better the seedlings and the finer their coloring. Muck and manure mixed did not produce as good seedlings as where the same quantity of manure alone was used. Where the bed was made of muck only, very favorable results were secured. White and Scotch pine were sown on all of these different soil tests. When the seedlings were one year old a top dressing of finely ground bonemeal was applied to one-third of each bed. The effects of this top dressing are most striking, especially on the beds where little or no manure was used. The seedlings on muck responded least, but on the check beds an additional growth of fully two inches was secured, while on the beds where the moderate quantity of manure was applied an increase of at least three inches was made. There was also a great difference in color, those where the meal was applied being much greener and brighter than elsewhere. This was true for the pine; but the bonemeal killed from one-fourth to one-tenth of the spruce.

As a result of these tests I would strongly recommend that one-year-old pine seedlings be top-dressed if they are to remain in the seed bed a second year; but it should not be applied to spruce.

Another series of fertilizer experiments, with chemical fertilizers entirely was started in the spring of 1908. A quantity of fine-ground bonemeal, acid phosphate, and muriate of potash was secured and applied in varying quantities. Nitrogen increases root and foliage development, acid phosphate hastens maturity, and potash increases root development, hence these three kinds of fertilizers were mixed as follows:

No. 1.	Fine ground bonemeal...	4 parts
	Acid phosphate	1 part
	Muriate potash	1 part
No. 2.	Acid phosphate	3 parts
	Muriate potash	1 part
No. 3.	Muriate potash	2 parts
	Fine ground bonemeal...	2 parts
	Acid phosphate	1 part

These fertilizers were applied to the beds in varying quantities before the seeds were sown and carefully worked into the soil. It is now too soon to make any statements as to results, as fertilizers do not seem to show much difference until the second year.

In the Adirondacks we are limited in our work to certain species on account of early and late frosts. A frost occurring in the early part of last June nearly ruined every one-year-old spruce seedling in our nursery. The most striking thing in this connection is that the red spruce grown from seed collected in the Adirondacks was more severely injured than any other spruce, our loss being practically ninety-five per cent. in one nursery and about sixty per cent. in another. A species of Siberian spruce was a close second. Norway spruce suffered about fifty per cent loss. The white spruce collected in the Champlain Valley showed about one-third loss. The loss of Engelmann spruce and Colorado blue spruce was too small to note. The Japanese larch was all killed, and the Siberian larch was uninjured. European larch in the plantations suffers severely from early frosts. Black locust and the walnuts are unable to harden in the fall, frost coming on and freezing the leaves even before they begin to change color. The planting of Douglas spruce is unsuccessful, because the frost injures the terminal buds.

PLANT FORMATIONS AND FOREST TYPES

FREDERIC EDWARD CLEMENTS

Presented before the Society December 17, 1908

In discussing the ecological kinship of forest types, it seems desirable to present first the results of an ecological analysis of vegetation. There is small need of harmonizing the views of ecologist and forester, for they are becoming more and more identical. During this process, however, there is distinct need of enabling the one to think and to speak in the language of the other. Both have attacked the same great organism, the forest. This attack has, however, been on opposite sides, and until recently neither has been able to see the other or to discover that he was at work. This has led to the assumption upon the part of each that he was alone in the work, and possibly that he alone was entitled to do it. The recognition of their mutual need has been delayed by the feeling on the part of the ecologist that the work of the forester was not scientific, and on the other hand that the ecologist was academic and not practical. It cannot be denied that there has been ample warrant for these, but the time has come for the clear recognition of the fact that each needs what the other brings, that a science of forestry must be both scientific and practical in the highest degree possible. Up to the present, we have gained this point of view only through the inexorable logic of circumstances. In the future, it will be made an intrinsic part of the training, not only of the forester, but in most cases, at least, of the ecologist as well.

Ecology took a long step in advance when it came to realize that the forest, and other associations of plants, was an organism, complex to be sure, but still much more than the sum of the individual trees in it. In a vague way, this idea had long been in the mind of the forester, but it remained for the ecologist to analyze it and give it scientific form. Once clearly grasped, this idea led at once to the fact that forests show both development and structure. The appreciation of this gave new impetus to the study and measurement of forest conditions, or habitats, a work glimpsed by Humboldt as early as 1805, but then neglected for almost a century. Out of this came the fundamental procedure in ecological investigation, a procedure, as follows from the above, equally fundamental and indispensable in forestry. In this procedure, the habitat, or sum of physical and biological factors, is the cause, the development of forest as of individual tree the response, and the structure of forest as well as of tree the final formal expression. In other words, the forest not only acts like a living thing, but is a living thing, with a development history and structure initiated and controlled by the habitat, much as are the development and structure of an individual plant.

In the actual study of the forest organism, and the individual plant, the ecologist discovers one important difference. The plant rarely requires more than a few years at most to reach the adult form. On the other hand, the forest often takes a century to reach maturity, and in many cases a century-old forest is still in its forest youth. For this reason, direct, first-hand investigation of forest development can only be of the most fragmentary sort at present. The forest can be studied in motion, as it were, but this movement cannot be easily traced to its conclusion. In consequence, it is necessary to use the method of reconstruction. In this, if skillfully done, the various stages of structure are shown up in their proper sequence, and give a picture of the life movement of a forest much as the individual films give motion in a moving picture. Thus recognizing that the development of a forest gives its structure, we must depend upon the latter to re-establish for us as much as possible of the development that has already disappeared.

The structure and development of formations, and of forests in particular, have already been treated in "The Development and Structure of Vegetation" (1904), "Research Methods in Ecology" (1905), and "Plant Physiology and Ecology" (1907), with which some of you are more or less familiar. In the hope, however, of making clearer the place of forest types among vegetation structures, I shall give a brief summary of the main points in structure and development.

The structure of vegetation may be viewed from three different standpoints. All three are equally an outgrowth of its development, though some are connected more intimately with it. These viewpoints are (1) its composition as to species, (2) the fundamental response to the action of physical factors, (3) the subdivisions or plant associations within the vegetation itself. In making these analyses, one must keep in mind that in vegetation action and reaction are constantly at work. Physical factors act upon the plants individually and in groups, and plants in turn react upon the factors, to be again influenced by the latter in modified form, and so on. Thus, the species which are acted upon, as well as the habitat or sum of causes must be reckoned with in any analysis; we must turn repeatedly from one to the other because of this fundamental relation.

In scanning the species of a plant group to discover the part they play, one sees that some are important, while others are relatively unimportant or negligible. This importance may be either a matter of reaction upon the habitat or a matter of number. Often it is both. Among the important species are some which are characteristic or controlling. These give the character or appearance to the group, and are consequently called *facies*. In forests and woodlands, the facies are the species of controlling trees;

in thickets, shrubs; on prairies, grasses; and elsewhere, more or less typical herbs. The lodgepole pine is the facies of one forest, aspen of another; Douglas spruce and Engelmann spruce are facies of a third, etc. *Artemisia tridentata* is the facies of sagebrush deserts, and grama grass and buffalo grass of the " short grass " plains. Next to the facies stand the principal species, often more conspicuous than facies except in forests, and usually represented by many more species. In spite of this, they are less controlling and do not give character to the formation. Finally, the term *secondary species* is applied to those plants which, because of lack of size, number, or permanence, play a very small part and may almost be said to be present by suffrance of the dominant species.

The fundamental structure of vegetation is due to its response to physical factors, and to its power to migrate, though very slowly. The first is primary, the second accessory. The nature of habitats is accurately reflected by the organic covering upon them, not only in the large, but also in detail. The major features of vegetation are determined by the arrangement of habitats. When the latter are placed with some regularity, vegetation shows a corresponding regularity: when habitats change abruptly or at haphazard, vegetation seems to show no order in its structure. Regularity in habitat arrangement produces the striking phenomenon known as zonation. Irregularity gives rise to the less striking but more universal and fundamental alternation. Zonation is the grouping found about ponds and along streams, on islands, and the slopes of mountains. Alternation is the " hit-and-miss " arrangement seen in vegetation in general, giving it a kaleidoscopic appearance. The two structures are often superimposed, making an extremely complex grouping. Forests usually show zonation, at least the vertical zones which are called layers. Alternation is a regular feature of them, even when composed of a single species, for difference in stands is only a minor kind of alternation.

The strict correspondence between vegetation and physical factors gives rise to a vegetation unit or plant formation for each habitat. One might well define a formation as the plant covering of a particular habitat or kind of habitat. The real difficulty lies in determining just what a habitat is, or rather the degree of difference necessary to set one area off as a distinct habitat. This difficulty has not been keenly felt as yet, because the areas worked have been few and far apart, and no comparative study of the so-called formations in them has been attempted. Sooner or later it will be necessary to delimit habitats and formations with care and exactness, if vegetation studies are to have meaning or value. It will be imperative to measure them accurately and to agree upon a quantitative as well as a qualitative basis for making distinctions. Meanwhile we can distinguish the general kinds of formations by the terms, forest formation, chaparral formation, prairie formation, sagebrush formation, bog formation, etc.

Though the unit of vegetation, a formation itself is far from uniform. It shows within itself conditions of alternation and zonation similar to those which produce formations in vegetation. These are seen chiefly in what are loosely called plant associations, or more definitely consocies. In a forest consisting of two or more dominant species, i.e., facies, these may be more or less uniformly mingled, or they may be segregated. The latter is the rule because the needs of two species are rarely identical. In one area, a certain facies will be dominant or exclusive, in another, a different facies, and so on. In places where they meet they tend to make a mixture. Each of these more or less definite areas constitutes a consocies. In addition, formations also exhibit societies, groups of principal species which give character to different areas during a certain part of the growing period, spring, summer, or autumn. Societies are conspicuous in herbaceous formations, but they are necessarily limited to the layers of a forest. A community is a group of two or more principal or secondary species. Communities appear regularly in nearly all formations, but they do not give them their distinctive character. A family is a group of individuals belonging to a single species. It is infrequent in established formations. Together with the community into which it develops, the family is characteristic of the earlier development of many formations.

The development of a formation is the result of certain processes which might well be called functions of this complex organism. These are aggregation, migration, ecesis, competition, and reaction. By aggregation is meant the coming together of individuals into families and communities, the beginnings of most formations. Migration is a usual factor in this process, though it also has a profound effect in carrying species into and out of established formations. Ecesis, or the making of a home, is practically synonymous with acclimatization. The term is regarded as more fortunate because it refers to the actual factors of a plant's home, while acclimatization seems to denote merely the general relation to climate. Competition needs no definition, though it should be clearly seen that it concerns chiefly, if not wholly in most cases, the two most important factors—water and light. Reaction is the effect of the plant covering upon the factors of the habitat and is seen at its maximum in the forest.

The development of a forest takes place through the constant action and interaction of these five processes. It is seen at its clearest where vegetation is starting on a soil newly formed or exposed, or one denuded by a burn. Migration brings about aggregation and ecesis, and these in turn make possible competition and reaction. Species near at hand find their way in quickly and in large numbers; those that are more distant enter more slowly. Pioneer species, weeds, etc., at first overrun the area because of their ready ecesis, but finally give way before species of slower movement and growth, but of greater duration. The reaction of pioneer species brings about conditions in which they are at a disadvantage before the later arrivals, and they yield to the latter, moving on to new frontiers, as is the habit of pioneers the world over. This gradual invasion of a new group of species and the disappearance of the preceding plant population is repeated several or many times at intervals of varying length. One plant group or stage succeeds another, a process characteristic of development, which is consequently termed succession. The character of each stage is determined by the factors of the area, and by the surrounding vegetation. Each stage reaches its maximum, after which it yields to the next. In extensive successions covering a long period, each stage is a plant formation. Of these, we distinguish initial, intermediate and final stages, or formations, distinctions based not only on their position in the succession, but also upon their character and permanence. The final stage is a stable formation. It is regularly but not invariably a return to the original formation when the area is a denuded one, or in the case of new soil, a formation of the same kind as the typical vegetation of the area concerned is produced.

The striking characteristic of all successions is their increasing stability. No matter what initiates a succession or what course it takes, it finally ends in a stable formation of a kind permanent in the region concerned. If the water and temperature remain essentially unchanged, the succession terminates in the original formation as a rule. Occasionally, however, one species excels its associates in ease or rapidity of reproduction, as with the lodgepole pine. This fact regularly enables a lodgepole forest to become the permanent stage on an area previously occupied by other species in whole or in part. When the cause which initiates the succession modifies the habitat essentially, it is clear that the original formation will not return. This is rarely the case in forest successions, since the changes which commonly initiate them do not modify the habitat profoundly.

Reversion to the original formation, or forest, in general composition and structure is so nearly the rule in development that this has been called normal succession. When the succession takes a new direction entirely, or terminates in a forest unlike the original, it is termed anomalous. When a new soil is formed, the succession that takes place upon it is primary, while that which is established upon a denuded soil is secondary. The development of a primary succession cannot be forecast with any accuracy further than the certainty that its final stage will be drawn from the surrounding species best adapted to maintaining a foothold in the conditions presented. The secondary succession will end, in the great majority of cases, in the original formation. In case of the forest, complete or partial denudation is the result of fire or the ax, and the resulting succession is always normal, i.e., the treatment of such an area must be based upon a fair certainty that the forest will re-establish itself. Primary and secondary formations differ in their complexity, length of life, and other characters, which are hardly relevant to the matter in hand. Before leaving them, however, it should be understood that forest or grassland is the final stable stage of nearly all successions, and that in the last analysis the forest is the most stable type. There is a temptation to touch upon the laws of succession and the methods of investigating them which have been laid down by the ecologist, but these must be passed.

In relating the idea of forest types to the ecological conception of development and structure, I have drawn my idea of them from Professor Graves' "Practical Forestry in the Adirondacks" (1899), and Mr. Zon's "Principles Involved in Determining Forest Types" (1906). We find the European foresters dealing with succession as early as 1844, in the work of Steenstrup, Berg, and others, but no mention is made of forest types as such. Neither Graves nor Zon gives citations of the use of forest types by others, and they appear to have been the first to characterize them definitely. Graves' characterization of forest types in consequence is taken as the original one. It is as follows:—

"If nature is left undisturbed, the same type of forest will tend to be produced on the same classes of situation and soil in a specified region. There will be variations within the type, but the characteristic features of the forest will remain constant, that is the predominant species, density, habit of trees, reproduction, character of undergrowth, etc. If a portion of the forest is destroyed by fire, wind or otherwise, the type may for the time being be changed, but if left undisturbed it will revert to the original form, provided the condition of the soil is not permanently changed. Thus in the Adirondacks, a group of spruce and pine on an island may be replaced after a fire by white birch and poplar. After a time, however, the former will creep back, and grow under the thin cover of birch and poplar, and eventually crowd them out. A good illustration of the same principle is found in Massachusetts, where in many sections the white pine formed an important feature in the original forest. After the pine was cut off, the hardwood predominated in the second growth. Now, however, there is abundant evidence that the white pine is increasing in quantity; and if the woods were left untouched the original type would return." This briefly but clearly describes two secondary successions of the normal sort. The forest type is here the final stage or formation of the succession, which repeats in general the original forest before it was destroyed by fire or lumbering. The correspondence is complete, and forest type and final ultimate formation are here exact synonyms.

In the application of this conception, Professor Graves says: "It is possible to differentiate the forest in the Adirondacks into a considerable number of types, but for simplicity only four have been recognized. These are as follows: swamp land, spruce flats, hardwood land, and spruce slopes." A detailed comparison of these types seems at once to reveal the fact that they are not forest types in the sense of being the last stage in as many distinct successions. They are too similar in constitution and apparently in structure to permit such an interpretation. In regard to the critical factor of water-content, swamp land is the wettest, spruce flats are next, followed by hardwood forest on moderate slopes, while steep spruce slopes with thin, stony soil are the driest. With the exception of black spruce, tamarack, and cedar, which are unimportant, the same species occur throughout the four types. The percentages of many of these are not widely different, as the following table indicates:—

	Percentage				Ave. Diameter			
	S.L.	Sp.F.	H.L.	S.S.	S.L.	Sp.F.	H.L.	S.S.
Red spruce	48	45	37	48	13	13	13	13
Balsam	13	9	2	5	11	11	11	11
Hard maple	3	4	13	6	13	14	14	14
Beech	3	9	21	10	13	13	14	13
Birch	18	20	19	20	15	16	18	19
Soft maple	4	5	3	4	13	14	14	14
Hemlock	7	9	5	7	16	16	17	16
White pine	.5	.15	.06	.42	17	21	14	22
Black ash	.9	.15	.04	.02	13	13	12	13
Cherry	.04	.08	.17	.09	19	12	16	14

The average diameter affords further evidence of the close similarity in growing conditions. Reproduction conditions are given only occasionally, though it is interesting to note that the second growth in spruce flats may be pure spruce in some cases, and an almost exclusive mixture of yellow birch and soft maple in others. It is futile to give an opinion without having studied the actual development of the various areas. All the printed evidence, however, goes to show that these four types are not the final stages of four successions, but that they are simply different groupings of the facies, spruce, birch, beech, and perhaps hard maple and balsam, all belonging to the same stage of a single succession or at most two. Spruce flats and spruce slopes are nearer each other in structure than the grouping upon the intermediate moderate slopes covered with hardwood, and even extreme habitats, swamps, and spruce slopes resemble each other more than the hardwood lands. At a guess, the final stage of the swampland is a tamarack forest, though it is possible that the succession is becoming anomalous through the ravages of the saw-fly worm. The other three situations would seem to belong to a beginning of the final spruce stage of another succession. The ecologist would regard these as consocies of one or two formations, in which the differences are perhaps the result of migration and ecesis as well as of physical factors. It is perhaps unnecessary to repeat that this is a conjecture based upon Professor Graves' paper and might not be borne out by an ecological study of the forest. This applies also to the recognition of forest types, if they are to be regarded as ultimate stages of successions, for the course of the latter can certainly be determined only by investigation through a number of years.

In his analysis of forests in order to discover the basis of forest types, Mr. Zon has said: "Tree societies, or forests, just like human societies, present a great variety of forms. As soon as you enter a forest you readily find that it is seldom uniform over a large area. Even the pure longleaf pine forest, typical for its tiresome monotony, proves upon closer examination not entirely uniform. A little attention and you will discover stands differing from each other in density, age of the trees, or character of growth, and you soon come to realize how difficult it is to find even in such a uniform forest two areas similar in every respect. Now the first step in any silvical study or attempt at forest management is to reduce the great variety of stands to a small number of types, each having characteristic features of its own and requiring a distinct treatment. The nearer we come to establishing natural types of forest growth, the deeper we penetrate into the true relationship existing between these types and the factors that produce them, and this is the most important contribution to silvics." He points out that there are two main causes of the differences between stands. " First, external physical conditions, and second, interference by man, and natural accidents." Differences in the age, density, or mode of origin of stands are regarded as too unimportant to furnish a basis for forest types.

The use of composition as a guide in determining types is also regarded as impossible. This is true of composition when used alone, for all the stages of a succession differ from each other in this respect, but only the final stage can be called the type. On the other hand, it must be recognized that any grouping of species is a response to the habitat, and that forest types must necessarily differ from each other in composition. The statement that " the changes which are brought about in a forest by the interference of man or by accident, cannot, therefore, serve as a basis for the establishment of fundamental forest types " is probably true of the rule but does not hold for non-reverting successions. In fact, the author has recognized that such changes do produce forest types, though he suggests that they may be called temporary, transient, or derivative types to distinguish them from fundamental forest types, which are the results of natural factors only.

Mr. Zon reasons justly that the physical conditions determine forest types, and of these, soil factors are the main ones for dividing the forest into natural types of growth. Water content is generally the most important, but humidity and temperature must always be reckoned with. As has been indicated before, however, the component species must always be taken into account, for more than one final type may occur upon the same habitat. The reproduction of the forest is taken as its fundamental process, and hence is regarded as the guide in determining what physical differences warrant the establishment of different types. Here again it is seen that differences in reproduction are often due to differences in the habits of species as well as to habitats, a fact clearly shown by the behavior of longleaf pine and lodgepole pine. Reproduction is the forester's term for development or redevelopment; it is the complex response of a formation to its habitat, which leads to succession. The result of reproduction is a forest type, of succession an ultimate or stable formation, i.e., a forest type and a stable formation of a succession are identical. This identity is made clearer by the author's insistence upon stability as the ideal for which a forester must strive in regenerating and caring for his forest. The change in stabilization is perhaps the most essential feature of a succession, and the succession terminates only because the habitat is finally occupied by a formation which, accidents excepted, is best suited to it and hence is permanent.

The application of the methods of forest types to forestry brings it into harmony with the fundamental principles of ecology. It places forester and ecologist upon the same basis in so far as the study of forest vegetation is concerned, and means that each will inevitably share more and more the view of the other. Both must bear in mind constantly that reproduction, development, and succession are at bottom the same great process, and that this process can be accurately and thoroughly understood and made of use only in so far as it is directly connected with the habitat factors which are its causes, just as the formational structures are its results. Detailed knowledge of a forest's development is the only scientific foundation for its treatment, but such knowledge is possible only through an investigation based upon factors, development, and structure. Such an investigation must be exact and quantitative to yield final results, and must rest upon instrumental measurements of the factors or causes, and upon quadrats or sample plot measures of results or structures. From its nature, the building of such a foundation will be a slow and painstaking task, in which quantity of result and time must be almost completely ignored, and accuracy and permanence alone considered.

The scientific study of forest vegetation must accompany forestry practice more closely, and just as soon as possible must precede it. Indeed, the only possible reason for delaying the adoption of this necessary treatment is to be found in the fact that forest management is not something that can wait a decade or more for the results of accurate investigation. In this point lies the whole contention of the forest ecologist that the time for thoroughgoing investigations to lay securely and permanently the foundations of practical forestry is fully come.

RELATION BETWEEN STATE AND PRIVATE FORESTRY IN PENNSYLVANIA

JOSEPH TRIMBLE ROTHROCK

Presented before the Society February 4, 1909

The writer was once introduced by the honored head of the National Forestry Bureau as the oldest American forester. My work, however, has been rather that of a propagandist than a forester. The first was a necessity, the latter is a result of the efforts of those who pioneered the cause. I have been witness to, and an humble participant in, thirty years of earnest effort to place the importance of forestry before the people of this country.

It would be impossible for me to forget all the steps by which the movement in favor of a rational system of forest protection and restoration has come to the front.

You, gentlemen, are to do your part in solidifying the movement, in bringing order out of the still existing chaos and in establishing your chosen profession upon an enduring foundation.

My brief paper is concerned chiefly with the woodlands of my own State, Pennsylvania.

At present the Commonwealth has in possession nearly a million acres of land as a forest reservation. In great part, this land has been purchased in a stripped condition, after the owners had removed a splendid forest growth. As far as I can now see, there are not more than half a million of acres additional that can be obtained by the State at present prices. It is a conservative estimate that there will remain in the hands of private owners at least six millions of acres of land which ought to be in timber, and would ultimately be more productive in that than in any other crop.

Here, then, we see there are two classes of timber land to be considered:

1st. Public Lands—controlled by the State.

2d. Private Lands—controlled by the individual or by corporations.

The existing conditions of these two classes are far from being identical! Perhaps the most important difference lies in the question of taxes. Our State lands should properly pay no taxes. If it is proper for the State to pay taxes upon its land holdings, then it would seem proper to pay it upon all its real estate. In strict equity it is as proper to pay taxes upon the ground on which the State Capitol stands as upon the forest land. Our Constitution declares, that "The General Assembly may, by general laws, exempt from taxation public property used for public purposes." Evidently, this places the whole matter in the hands of the Legislature. As the largest State forests are in our poorest counties, exemption from taxation of the State lands would work a hardship. It has been enacted that the State shall pay a "fixed charge" of five cents an acre upon its forest land; of this, three cents an acre shall go to the public schools and two cents an acre to the roads of the counties wherein the land lies. This provision, however, has been greatly abused, especially in regard to the road clause, for in some instances the taxes levied upon the citizens have been diminished by a sum equal to that received from the State, and the money has seldom been used for the roads within the district producing the money. As a consequence, the roads within the reservation have been neglected until, instead of being thoroughfares, they are often obstacles to travel. It is hoped that legislation may remedy this serious defect and compel the expenditure of the money within the district from which it is derived. In some instances the Forestry Department of the State has undertaken to keep the public roads in repair on the proper plea that it is done for forestry purposes.

Taxation of private and corporation forest lands is with us still in a most unsatisfactory state. In spite of existing laws, private forest lands receive practically no protection from the State, though it is for this very purpose that taxes are paid. Furthermore, the time has come in which such lands are more important even to the State than to the owner. Yet they are often taxed so heavily as to compel the owner to cut the timber from them. It requires no argument to show that such a public policy is absolutely ruinous, and that the burden of the calamity will ultimately fall most heavily upon the Commonwealth. Two remedies have been proposed.

One is to grant a *rebate* of taxes upon land in which timber in specified condition remains, because under our Constitution an *exemption* from taxes is forbidden. Theoretically this seems easy, but as a matter of fact, it is a failure, because at the next assessment the tax upon a property claiming the rebate is increased by the amount of the rebate.

The second plan is to designate private, or corporate, forest lands as Auxiliary Forest Reservations, and to have the surface, with its trees, assessed for taxation at the sum of one dollar an acre, and allow a separate taxation for mineral or other values. This plan was before our last Legislature, and was ultimately defeated by a very slender majority. It will probably be brought up again this winter.

In this connection it may be well to allude to the fact that in a revision of our school laws it is now proposed that the net revenue from the State forest reserves shall go toward a permanent fund for educational purposes. Of course, it is recognized that it will be years before any such net revenue will be available. But the fact that the proposition is seriously made by competent authority shows how favorably the forestry work is regarded in Pennsylvania; and I am of the opinion that it would be well if such an alliance were effected between forestry and education.

Shall the State aid the citizen forest planter, and if so to what extent? There appears to be a general demand throughout Pennsylvania that the State nurseries should furnish seedling trees for forest planting. It can hardly be said that aid, if given, would interfere with any existing market which our nurserymen have; though it might be regarded as jeopardizing a prospective market. I do not regard this aspect of the problem so serious as the question whether or not State aid in obtaining trees would be any real assistance to forestry by the citizens. It is notoriously true that but little value is attached to that which costs nothing. To plant trees and neglect them, instead of helping forestry, is a distinct hindrance.

Would not actual forest planting be more common and more successful twenty years hence, if at least a nominal charge were made? I confess I am in doubt upon this point, and merely raise it to call attention to it.

Protection to private forest land comes mainly under two heads: Against trespass and against fire. There can be no doubt that it is a function of the State to offer protection in *each* case. It is, however, quite another question as to whether this work belongs to a State forestry department or bureau, though it is generally assumed that it does. After an extended experience, I am inclined to think that care of private forest lands is not a duty of the State bureau or department, and I base my opinion upon a belief that it is not in the interest of either the owner or the State that such care should be given. There are innumerable laws upon the statute books of the States against forest fires and those who start them. Most of these laws would be helpful, if enforced, and no number of even the wisest laws would be helpful *unless enforced.*

The average citizen fails to realize that no human law is self-enforcing. It is designed for his protection, but before it can become effective he must see that it is enforced.

Nothing but dire necessity, in most instances, will compel the sufferer to move in the matter, yet if it is not his duty, whose duty is it? Education in the duties of citizenship is more necessary for the suppression of forest fires than additional legislation. With one exception, our Pennsylvania fire laws are good, and if enforced would soon bring satisfactory results. The single feature which I condemn in our forest fire laws is the price we pay for their suppression. It is right that those who fight the fires should be paid, but it is wrong that the price paid should be large enough to induce evil-disposed persons to start fires to be paid in suppressing them.

There is needed with us, and with other States, more education concerning the losses which these fires cause. The most effective way of doing this would be for the courts of our States to hold the officers, appointed by law to look after the fires, to a more rigid accountability for the full performance of their duties. Education through such channels would quickly permeate to the people. Unless the courts do come to the rescue, laws are of but little avail. There are counties in Pennsylvania in which every obstacle that human ingenuity, combined with authority, could devise has been thrown in the way of those who sought to bring incendiaries to justice.

A well-known, clear-headed business man, who has been all his life in the lumber business, recently stated that the most economical way to protect the forests against fire was to have them thoroughly guarded during the danger period. We have had a most disastrous experience during the last autumn. It actually cost more to suppress the forest fires than it would to have effectually prevented them, and we lost the timber besides. No statement that I can make more positively declares the utter folly and short-sightedness of failure to prevent the fires. The whole success of the forestry movement hinges upon prevention, rather than suppression.

The railroads in Pennsylvania, as elsewhere, have been conspicuous sinners in creation of forest fires, but bad as they are, they have received, if possible, more blame than they deserve, as far as the proportion of the fires they start to the whole number started is concerned. The small farmer burning brush upon his clearings—if our statistics are to be trusted—creates more fires than the railroads. There is this to be said, however, that those who control the expenditures of railways are usually better informed upon the disastrous consequences than the small farmer, and hence should be held to a stricter accountability.

It is hard to win a suit against a railroad, as we all know, and their able attorneys will deny to the uttermost any lack of care on the part of their clients; but with a frankness which did him credit, a vice-president of a leading railroad once advised me that it would be unwise for the company to start any tree planting operation along their right-of-way, because their own engines would burn up the young trees.

It is a waste of time to discourse upon the wickedness and the folly of a railroad destroying that which becomes a source of revenue to it. Efforts in that direction have been failures. It may, however, be confidently predicted that in the near future it will be found cheaper to prevent these fires than to pay for the resulting damages. The mere increase in the price of lumber will lead inevitably to this.

It may be found necessary to limit the fishing and hunting seasons to periods in which the danger from forest fires has passed, for there is no doubt that a considerable percentage of the conflagrations comes from ignorant or careless sportsmen.

There is one relation of State land to the people which merits consideration—as outing grounds. In spite of all that has been written and said upon the question of forestry, it does not appeal strongly to the average citizen. In fact it is still looked upon with suspicion by a very large number of good citizens, or indeed, as simply one of the many means of extracting money from the public purse. Time will, no doubt, dispel most of these delusions; but we can poorly afford to wait for its slow operation! We need an immediate change in public sentiment. The surest, quickest way to effect this change is to invite the public out on the State lands, and to have each person feel that the land is his for any good he can get out of it without injury to the purpose for which it has been set apart. It is not enough simply to tolerate the people on it. No great interest can be awakened by the simple fact that it is owned by the State. My idea is that, as far as possible, suitable places should be specifically set apart as public outing grounds.

There are thousands of persons who neither hunt nor fish and whose means are too limited to visit a costly summer resort. To them such a place would be an attraction and a place for restoration to health. No nation is stronger than the aggregate of its citizens. The countless sanitaria which are springing up over the country are doing a splendid work, and the State moneys appropriated for them are in the main well bestowed, but it is infinitely better to prevent than to cure disease. Any State which can afford to cure the sick can better afford to prevent their becoming sick. It is cheaper. It increases the productive capacity of the people. Liberal appropriations for this work must in the near future be regarded as a duty of State or National Government.

There is another aspect of this problem quite apart from the public health. On our forest reservations in Pennsylvania thousands of persons each year go to hunt. President Roosevelt has wisely recognized the importance of expert markmanship for the safety of the nation. He is himself an example of the hunter patriot. Our ready-made riflemen are, as a rule, recruited from the ranks of our hunters. I cannot forget that it was from the backwoods of Pennsylvania that the famous "Bobtail regiment" came to render such efficient service during our Civil War. It is well worth while to keep the public lands fully stocked with game, in order that we may continue to nurture riflemen for service in time of need. This leads naturally to a statement concerning the further utilities of private forest lands. In my State it is unlawful for the owner of a deer park to kill more than one deer in a season, and he is not allowed to sell a pound of the venison which he has raised. These deer were born and raised in capivity. They never were the property of the State. To all intents and purposes they are domestic animals, and they should in all respects be treated as such; killed and sold whenever there is a market for the meat. It would be a notable addition to the forest resources and a most welcome addition also to the food products of the country.

I have thus briefly endeavored to convey some of the conclusions which have impressed themselves upon me during the past year in State forest service.

SOME NOTES ON THE YELLOW PINE FORESTS OF CENTRAL ALABAMA

RALPH CLEMENT BRYANT

Contributed

In 1907 the spring term of the Senior Class of the Yale Forest School was spent in Clay and Coosa Counties, Alabama, a region located in the central part of the State, in the rolling foothills of the Appalachian Mountains.

In connection with the regular course of instruction in field methods and lumbering, considerable attention was devoted to a study of the reproductive capacity of longleaf pine, to determine if possible whether forest management could be successfully applied to these lands and if so under what conditions. The results secured cannot be regarded as final, but a number of facts were brought out by the study that are of distinct importance. The region was well adapted to the investigation, because lumbering had been carried on in the vicinity for twenty-one years. During the last seven years of this period the timber was cut to a diameter * limit of fourteen inches, and during the previous fourteen years to a sixteen-inch diameter limit, because these sizes represented the smallest trees which the company believed they could cut at a profit.

The Forest Service in 1905 prepared a working plan † for these holdings, the object of which was to provide for a second crop. The main features of the scheme recommended were cutting to a diameter limit of eighteen inches and the protection of the cut-over lands from fire. The provisions did not prove acceptable and were abandoned after a short half-hearted trial.

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* Diameter breast high is referred to in all cases unless otherwise specified.

† Bulletin 68, Bureau of Forestry. A Working Plan for Forest Lands in Central Alabama.

The pine forests in Central Alabama consist of moderately open pure stands, extending over large areas and containing from five to eight thousand board feet of merchantable timber per acre. Although a wide range of diameter classes does not appear, there often are found a varying number of thrifty or suppressed poles among the mature trees. The regularity of the virgin forest is broken by occasional patches or groups of young growth which are generally too small for saw-logs.

The effect of attempting to apply a method of cutting to a diameter limit in a forest of this kind can have but one of two results, namely, the removal of the entire stand of vigorous trees over large areas, if the limit is set at fourteen inches, or if the diameter is set at eighteen inches, the amount of merchantable material left standing is so great that logging proves too costly for consideration.

Cutting to a fourteen inch limit usually leaves standing a varying number of poles, but these are nearly always of an age approximating that of the felled trees, and are badly suppressed. The rate of growth of these remaining trees determines the time in which a second crop can be secured, and on their reproductive ability depend succeeding crops. It is, therefore, very important that these two factors be thoroughly understood before second or future yields are predicted.

Measurements taken on cut-over lands showed a current annual growth of one-twentieth of an inch. This statement is based on measurements taken on 343 trees growing on lands logged between 1887 and 1908. Plots one acre in extent were selected on all sites represented in the region, and from each tree a section was cut at breast height, and the current annual growth since logging measured. The trees on the plots were characteristic of the growth over the entire logged area and the data secured from them form a safe basis for the prediction of future yields for cut-over pine lands in this section.

The following table exhibits, as a whole, a fairly uniform rate of growth for most diameters. Those showing the most marked variation from the average are based on a small number of trees, which probably accounts for their irregularity.

TABLE I

RATE OF GROWTH OF YELLOW PINE ON CUT-OVER LANDS
(Central Alabama)

Diameter breast high. (Inches.)	Current annual growth since logging. (Inches.)	No. of years required to grow 1" diam.	No. trees measured.
5	0.0331	30	9
6	0.0400	25	39
7	0.0433	23	33
8	0.0397	25	44
9	0.0517	19	55
10	0.0658	15	45
11	0.0523	19	30
12	0.0423	23	33
13	0.0417	23	22
14	0.0790	12	16
15	0.0508	20	11
16	0.0480	21	6

Extensive valuation surveys made by the Bureau of Forestry in 1905 (on the tract on which these figures were taken) show that the average number of trees per acre of nine, ten, and eleven inches in diameter is eight and three-tenths. If we assume that a twelve-inch diameter limit is the minimum at which the future crop can be cut at a profit (this is two inches lower than the present minimum limit of lumbermen), we find that in twenty years only the present eleven-inch diameter-class can be harvested; in forty years the present ten- and eleven-inch classes; and in sixty years the present nine-, ten- and eleven-inch classes; the total yield * at the latter time being only six hundred and eighty feet B.M. per acre.

TABLE II

FUTURE YIELD OF YELLOW PINE ON CUT-OVER LANDS

Present diameter. Inches.	9	10	11	
Diameter in 60 years. Inches.	12	13	14	
Contents. Feet B.M., in 60 years.	57	83	112	
Average number of trees per acre.	2.9	2.9	2.5	
Total contents of diameter class. Feet B.M., in 60 years.	164.9	238.8	284.4	688.1

The present owner of the land is not interested in a third crop, but feels that if he "can count on having a second crop averaging three thousand feet to the acre ready for the axe by the time he has finished marketing the present crop (twenty-five years), the company is willing to modify its present logging methods to the extent of cutting to a diameter limit and avoiding injury to young growth. It is unwilling to incur expense in protecting its lands against fire, however, either for the purpose of improving the second crop or for that of hastening the production of a third."

The requirements are for a cut of three thousand feet per acre in twenty-five years, and it is evident from the figures given that any scheme of cutting to a reasonable diameter limit cannot produce the results desired.

The reproductive ability of trees left on cut-over lands has not been thoroughly understood and too much reliance has been placed on them as a source of future crops. The

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* In calculating this yield, use was made of the table of volume of longleaf pine and the tables of present stand given in Bulletin 68, Bureau of Forestry, p. 16 and pp. 20-28 respectively.

trees are of four classes; namely, saplings, thrifty poles, suppressed poles, and an occasional large diseased tree that is too defective to cut.

Productive saplings were not found in the region, although the season of 1907 was a favorable one for seed production. However, Dr. Charles Mohr states * that a longleaf pine sapling may begin to bear flowers and fruit when the tree reaches its second decade, and it is probable that occasional specimens can be found in this region that are seed-bearers. However, they are so few in number as to be a negligible quantity.

Small poles (35 to 50 years old) bore very few seed and so far as could be learned those produced were sterile, for no reproduction resulted. Small crops of seed are borne by thrifty poles ten to twelve inches in diameter (60 to 85 years old) but not in sufficient quantity to insure ample reproduction.

The suppressed poles are usually long and spindling and often have a short tufted or a scraggly one-sided crown, which is so thin and scanty that it cannot furnish nourishment necessary for both the sustenance of the tree and seed production. Only a very small percentage of suppressed trees bear cones, and these seldom contain fertile seed. All thrifty trees in the vicinity were productive during 1907, and suppressed poles would have been so, had they possessed fecundity.

Large defective trees with a good crown development are fairly productive. These trees are often too poor for profitable utilization, but if left standing will be of value as seed trees. However, they are not sufficiently abundant to restock more than a small percentage of the total area.

The observations proved conclusively that in Central Alabama satisfactory reproduction of longleaf pine cannot

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* Bulletin 13, Bureau of Forestry. "Timber Pines of the Southern United States."

be secured from the usual stand remaining on cut-over lands where the mature timber has been cut to a diameter limit of fourteen inches, for trees of this diameter or less do not bear seed in sufficient abundance to insure a future crop of timber. The investigation showed that the most prolific trees range in size between sixteen and twenty-four inches (100 to 175 years old), and the diameter limit method is not the one to secure their presence on cut-over lands for reproductive purposes.

There are several means by which reproduction may be secured in yellow pine forests. The "stand" method where successive cuttings are made throughout the mature forests, the "strip," and the "group" methods would secure a well-stocked forest under proper management. However, the modern logging railroad with its expensive construction, maintenance, and equipment forces the lumberman to remove, at one felling, all the merchantable timber that is to be cut for many years, and therefore these systems are not acceptable to them.

Reforestation of yellow pine lands by planting would not be practical, for the tree possesses a very long taproot, and the production and planting of the stock would be too expensive for consideration.

The use of seed spots might meet with some success, for the seed germinates readily with little preparation of the soil, but this method also would be costly, because of the labor involved in seed collection and distribution. It may prove feasible for restocking large areas of denuded lands on which artificial means must be employed because of the absence of large thrifty trees.

The dense reproduction that springs up in the virgin forest indicates that a "clear cutting" system could be applied during the spring of the year, subsequent to the fall of seed, when the conditions are favorable for germination previous to logging.

The removal of the timber by animal logging, which is customary in the region, does not disturb more than twenty-five per cent. of the forest floor in stands where the timber runs six to eight thousand feet B.M., per acre. The accumulations of brush that are too dense for seedlings to thrive under them do not cover more than five per cent. of the area, so that seventy per cent. of the ground remains undisturbed. The reproduction on this area is sufficient to insure a fully stocked stand if the crop is protected from fire.

This method may be used only during the first part of the growing season, because during the latter part the seedlings in the mature forest suffer from lack of moisture and sunlight and die in large numbers. The method is applicable only for periods coincident with seed years and can be used solely as a means of supplementing the regular management practiced.

In heavy stands the "scattered seed" method offers the best opportunity for the removal of a major part of the crop at one operation. The success of this method demands that vigorous, healthy, middle-aged trees, sixteen to twenty-four inches in diameter, be left standing. The number of trees required is governed by their height and the slope of the land. Longleaf pine seed is distributed on level land for a maximum distance of one and one-half times the height of the tree. The distance of effective seeding is not greater than the height of the tree. Trees sixteen to twenty-four inches in diameter have shafts ranging in length from eighty to one hundred feet and four to five of these trees distributed with regularity must be left to effectually seed one acre. These contain from two to six hundred feet board measure each. Therefore, from six hundred to three thousand feet of the best merchantable timber must be left on the ground for a future harvest. Stands averaging two to three thousand feet per acre cannot be handled in this manner, because all merchantable material must be cut at one felling to make the operation profitable. Here natural reproduction must be secured previous to logging. These forests usually grow on inferior soils, but the open character of the stand would encourage reproduction, and favorable conditions would result with effective fire protection.

Longleaf pine seed years occur in Alabama approximately quadrennially. The problem of securing a crop of seedlings on the areas cut over between seed years is not easy, for a heavy growth of grass and ferns springs up after logging and in two to three years this becomes so dense that the herbage must be burned off previous to the fall of seed, so that they can reach the mineral soil. Where there is some young growth on the ground this would destroy a considerable portion of it, but the choice lies between the protection of a poor stand, or the destruction of a portion of all of it, in order to secure a better stocked stand. There is an element of risk in this, for conditions may be unfavorable for seed development and germination, and it may not be possible to secure a stand until one or more seed years have passed.

The quantity and quality of the seed crop may be foretold for at least a short period in advance of its fall, but it is not possible to reckon with climatic conditions that may destroy the crop. Damp, warm weather during the late fall or early spring may cause the seed to germinate on the leaf litter, or even in the cones, and in either case, the succeeding frosts kill the succulent plants and germinated seeds, and destroy all hope for reproduction until another period of four years. This may mean that the restocking of the area will be delayed for seven years. During this time grass secures a strong hold on the land, and where a heavy sod forms, a serious obstacle is offered to reforesting the areas, because seedlings are choked out before they have sufficient root development to cope with the herbage.

The treatment to which cut-over lands should be subjected, where reproduction is lacking, will depend somewhat on the relation of the cutting season to the seed year. Burning off the ground cover is essential and during seed years this would take place late in the year previous to the fall of seed and before logging, so that the only refuse on the ground after logging would consist of unmerchantable logs and crowns. This refuse is seldom responsible for the great damage that is done to young growth, because the herbage growing on cut-over lands is the chief fuel of fires. The crowns are composed of coarse, brittle limbs that are not readily inflammable. Three-fourths of them are badly smashed in falling and lie close to the ground in a position for most rapid decay, and they offer a minimum of fire danger. The most inflammable portion of this slash is the foliage which falls after two years, and thereafter is not a serious menace.

If felling occurs between seed years and the land remains unseeded for more than a year subsequent to logging, it is again necessary to burn off the ground cover of the logged lands before the seed falls. The logging débris complicates the work because the brush must be lopped, and, if dense, removed from the vicinity of seed trees and thrifty young growth. Further handling of the slash is unnecessary.

Brush burning is not essential, for fire can be kept out of the slash as easily as it can be kept out of areas where the dêbris has been burned.

Although fire is often an essential tool of the forester in securing reproduction in longleaf forests, it is a scourge as soon as the crop is started. It is fatal to seedlings until they begin to grow rapidly in height, which is usually at the age of four years. During the six or seven succeeding years the foliage may be injured several times by surface fires before the plant succumbs. At the age of twelve years stands are usually immune to light fires, although growth may be retarded by the loss of the ground cover.

An effective system of fire protection is one of the absolute essentials for the management of yellow pine in the South.

The protection of the young growth against animals is of little importance in central Alabama, for stock laws forbid the natives to pasture any form of animal on the open range. The extensive damage inflicted by hogs on seedlings in other sections does not occur here. There is no incentive to burn forests because the settlers do not benefit from the range. This assists materially in keeping down surface fires.

Turpentine orcharding is conducted on an extensive scale and because of the ignorance and carelessness of the labor employed, and the crude methods of extraction, it has a marked effect on the forest. The box system of extracting crude turpentine from the tree is widely practiced and although an improved scheme, the "cup and gutter" system, has been introduced, its use is not general. The boxes weaken the bole, kill five to ten per cent. of the bled timber during the four years of operation and are a serious fire menace because the resin they contain is inflammable and a few fires are sufficient to seriously injure the tree. The "cup and gutter" system reduces the number of trees killed to about one per cent. and lessens damage from fire because it cannot gain headway on the pitchy bole, and scarification does not appear to seriously impair the vitality of the tree unless it is nearly girdled. It is not, however, popular with many workmen and some difficulty is experienced in its use. Turpentine orcharding necessitates the selection of seed trees several years in advance of logging. Scarified trees, especially those that are "boxed," are not suitable for seed purposes, because of the added danger from fire and disease to which they are subjected, but during turpentine operations the selected seed trees may be damaged and recourse to bled trees would then be necessary.

The extraction of crude turpentine has led to numerous practices that are detrimental to the forest, such as the boxing of thrifty poles that at best yield only a small amount of resin. The deep gash made at the base of the tree greatly weakens the bole, and it is usually blown down during the first severe wind storm. Even if it stands, it is too small to cut when the area is logged and it is left behind to encumber the ground—not only a total loss to the landowner, but a menace to the remaining stand.

Fires also play havoc in the turpentine woods, and in order to keep them under control it is customary each fall to burn the scanty growth of grass and the thin carpet of needles. This burning is often done by careless laborers and the fires get beyond control and spread over large areas, doing great damage to young growth and bled trees. This practice has not proved so destructive in Central Alabama as in some sections, but its evil effects were observed.

The greatest damage to the cut-over lands arose from the use of coal- and wood-burning locomotives on the logging railroad. No efforts were made to provide spark arresters or in any way to prevent the spread of fire from areas ignited by the locomotives. As a consequence, the carelessness of train crews was responsible for the greater number of fires on cut-over lands.

In the virgin forest where turpentine operations were not in progress, the fires were started by the log-cutters, who burned the undergrowth and litter for the ostensible purpose of driving out rattlesnakes and to make walking easier. The area of virgin forest and cut-over land burned annually could be reduced to a small per cent. of the present total if a patrol were maintained along the logging railroads during the dry periods and the wanton firing of the forest by employees stopped.

Tables of age on a diameter-breast-high basis, which were prepared for this tract by the Forest Service,* show that it requires eighty-five years from seed for a tree under favorable circumstances to reach twelve inches in diameter, and one hundred and eight years to reach a fifteen-inch diameter, so that the present generation of owners and perhaps the next, will be unable to harvest another crop from the land. This is discouraging, for the expense of reforestation and protection, coupled with the annual payment of taxes, makes so large an investment, when compounded for eighty-five years or more, that a timberland owner has cause to doubt his ability to practice profitable forestry on his holdings; and southern lumbermen will not invest money in the improvement of their forest lands until the profit secured from the manufacture of lumber is greater than it is to-day.

The existing knowledge concerning the silvics of longleaf pine is so meager that extensive research and experimental work must be conducted before the problem of management can be solved. This study should cover a wide range of conditions because the soil and climate are so varied throughout the longleaf belt. Private citizens cannot be expected to undertake such work, and it is not probable that the Government will take active steps to carry on studies except on its forest in Marion County, Florida. This investigation is of vital importance to the States within whose boundaries the longleaf forests lie, and they should take some action soon to determine the means by which these forests may be successfully managed and perpetuated.

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* Bulletin 68. Bureau of Forestry.

A STUDY OF THE REPRODUCTIVE CHARACTERISTICS OF LODGEPOLE PINE

GORDON EDWIN TOWER

Presented before the Society January 12, 1909

The management of lodgepole pine constitutes one of the most important silvicultural problems in the West. There is a constantly increasing demand for it in the National Forests, and the forest officers have the task of making sales and at the same time providing for successful reproduction. In spite of the numerous investigations which have been made of lodgepole pine foresters are not yet agreed as to the best methods of handling it. With further study and the proper correlation of the information already secured, the management of the lodgepole type should prove no more difficult than that of other commercial species.

How best to secure good reproduction following the removal of the timber is a point, therefore, still in dispute, and the purpose of this article is to bring forward information which it is hoped will be helpful in clearing up some of the perplexing questions relating to its growth and reproduction.

The writer will endeavor to show, among other things, that there is a well-defined and very distinct variation in the species aside from the generally accepted differences due to the factors of locality, such as soil, moisture, altitude, and exposure, and furthermore that the difference is associated with a particular quality in one of the physical factors.

The first general observations of the lodgepole pine led to the assumption that it was a species well adapted to reproduce itself under adverse conditions, and that any opening made in the forest would be quickly filled up by new growth. Considering the nature of the reproduction which commonly follows the destruction of the forest by fire, it is quite natural that such an impression should be created. This was not entirely because scattering or deficient reproduction on some areas was not noted, but because such conditions were not easily accounted for by general observations. To presume that the restocking of such areas would somehow take care of itself was naturally the easiest way out of the difficulty. A careful study of conditions by means of sample plots * proved that such a view was erroneous, and disclosed the fact that reproduction in the lodgepole type was not always so readily secured as at first supposed.

The more definite information secured by these later studies is a valuable contribution to our silvicultural knowledge of the species. If, however, cutting in the type is conducted in strips, as has been suggested, without due regard for certain peculiarities of the species, the natural restocking will either be very unsatisfactory or will fail entirely to take place.

In securing the usual information regarding the silvicultural characteristics, there are some points pertaining to the seeding habits of the species which so far seem to have been either overlooked or considered of secondary importance, and it seems to me that these must be carefully noted and properly correlated with the other facts. Then the practical application of our accumulated knowledge will secure the best reproduction that is possible; otherwise we will be working against nature instead of aiding her.

Even were it desirable, it would be impossible to give consideration at this time to all the facts relating to the reproduction of the lodgepole, and the scope of this article

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* E. R. Hodson—" Silvical Notes on Lodgepole Pine," Vol. III., No. 1, Page 82—Proceedings of the Society of American Foresters.

will be limited largely to a consideration of those points which, with the information already obtained, will serve to round out our present understanding of the silvicultural characteristics of the tree.

The thing which the forester needs in his practical work is definite information in regard to the reproduction of a species. With a good understanding of the character of the reproduction that may be expected, its abundance, and the distribution over the area, he is ordinarily well enough prepared to proceed intelligently with the management of the forest. In handling commercial species like white pine and red spruce in the East, Douglas fir, white pine, and sugar pine in the West, the future of the forest very likely has not been materially endangered on account of the lack of definite information regarding seed production. In the case of the lodgepole pine, however, it seems to me we are dealing with a species possessing peculiarities which demand that we go a step farther and observe the seeding habits of the species very carefully in order to better secure satisfactory reproduction.

In the first place it is necessary to recognize that the lodgepole pine presents two very distinct phases in its reproductive functioning. One phase is that of the production of closed cones which remain on the trees for twenty or thirty years, and the other of cones opening at maturity, or very shortly thereafter, which do not persist on the branches for any great length of time. It was forced upon the writer's attention in a rather striking manner that this difference in the opening of the cones was due solely to a difference in the character of the soil. The closed cones that persisted on the branches and trunk were produced in stands growing on a soil rich in lime, while the other condition was the result of a soil having a low content of lime, that is, a silica soil. Based on this difference in the soil, two divisions of the type can be made, which can be most conveniently designated as the lime-form and the silica-form.

The question of whether the cones will be serotinous, that is, remaining closed on the trees, or will open at maturity or very shortly thereafter, resolves itself into one which can be answered by the nature of the soil, or by the character of the rock formation. For example, the breaking down of a granite formation would produce the silica soil of poor lime content, while the limestone formation,—both metamorphosed and unmetamorphosed—would give a soil rich in lime. Vice versa, the presence of the lime-form or silica-form of forest would determine in a general way, at least, the kind of soil and the character of rock in any given locality. Hilgard in his investigations in Mississippi was so forcibly impressed with the close correspondence of the geological formations to the vegetative zones, that he came to rely very largely upon the latter as indicating the probable occurrence of rock formations, otherwise not apparent, especially in a level country.

It perhaps would be well at this point to make brief mention of some investigations carried out in Europe and the United States relating to the influence of lime soils upon the character of plants. Several European investigators have demonstrated that a calcareous soil produces a difference in the general character of closely related species of plants. The influence of lime upon the structure of plants was first investigated experimentally by Bonnier as early as 1879. Later, Nägeli and Christ proved that the closely related plant organisms of closely allied species of gentians and rhododendron behaved differently as a result of the chemical composition of the soil. Among trees, Schimper states that the sweet chestnut (*Castanea vulgaris*, Lam.) and maritime pine (*Pinus pinaster*, Soland), cannot tolerate a calcareous soil. According to Chatin, even three per cent. of calcium in the soil is fatal to sweet chestnut. Fliche and

Grandeau demonstrated that there was a distinctive action of calcium upon the structure of plants and on plant metabolism. In extensive researches made by them in the Champfétu forest, near Sens, they found that Scotch pine (*P. sylvestris* L.), Corsican pine (*P. laricio Poir*), larch, silver fir, spruce, oak, and birch thrived equally well on a calcareous soil of chalk and on a siliceous soil of sand and sandy clay, while the maritime pine of the sweet or Spanish chestnut thrived best only on soils poor in lime, remaining stunted on calcareous soil and soon dying. Schimper states further that the Mugho pine (*P. unicinata Gand.*) exhibited dissimilar physiological properties in the lime-form and silica-form.

In the United States, Hilgard has investigated the influence of soil upon forest growth in the case of several different species. With post oak (*Q. minor Sarg.*) and black jack oak (*Q. marylandica, Muench*), he found a very decided difference as a result of chemical variation in the soil. On sand and black prairie soil, they were stunted, while on calcareous soil they were tall and with a different ramification of the branches. He states that the red cedar (*Juniperus virginiana L.*) grows tall only on the sufficiently calcareous soils, and in the states of the Mississippi Valley its occurrence is an unfailing indication of calcareous land. Hilgard's investigations show that the differences in the growth and form of trees on rich lime soil and one poor in calcium is more common and apparent in hard woods and not so marked in conifers. The red cedar is the only instance which he cites of a conifer having a different form as the result of growing on a calcareous soil.

In the case of the lodgepole pine the presence or absence of an abundance of lime in the soil not only affects the general appearance of the forest but has an important bearing upon the opening of the cones and the production of seed. Trees growing on a sandy soil poor in lime produce cones which open at maturity or very soon after ripening and do not persist long on the trees. On the lime soils the cones are very persistent, rarely opening on the trees at maturity, and often remaining closed for thirty or more years. Furthermore the time and very often the manner of the seed dissemination become greatly altered in the two forms. In the lime-form, too, the cones are closed very effectively, the scales being pressed tightly upon one another, making an hermetically sealed chamber impervious to water, and in which the vitality of the seeds is preserved for a very long time.

Just why the cones of the silica-form open early, while those of the lime-form remain closed, cannot be readily explained. A thorough drying of the cones of both forms causes them to open, and we would quite naturally presume that the difference is more or less closely related to the soil moisture conditions. On the siliceous soil with its poor water content, there is less moisture available to be supplied to the cones, and they open, therefore, as soon as mature. The fine, compact lime soil, on the other hand, has a better water content so that more water may be supplied to the cones, and these remain closed in consequence. This, however, does not prove to be the case. In the lime-form, as long as the stem of the cone remains united to the parent wood, moisture can be supplied to them, but when, as often happens, the stem of the cone becomes separated from the parent wood as a result of the growth in diameter, no moisture can be supplied directly to the cones. The latter condition is of very common occurrence, and yet cones do not open which have had no direct connection with the woody tissues for twenty-five or thirty years.

Because of the difference in the opening of the cones it is evident that the lime-form and the silica-form will bear a far different relation to the regeneration of the forest, not only in the quantity of seed available at a given period, but in the time it is liberated. When the regeneration of the lodgepole pine forests is to be accomplished through natural reproduction, it is necessary that the management of the forest be modified to meet the conditions suitable for each soil. A system of cutting that secures a good restocking in one soil might produce an opposite result on a soil having a wide difference in its lime content. The manner of disposing of the tops will also be important because of the relation which this bears to the reproduction.

Seeding Habits.—Some idea of the relation of the two forms to the seeding habits has probably been obtained from the statements already made. To what extent the reproductive power of the two forms varies, can as yet only be conjectured. In a general way, the abundance of seed produced by a species is taken as one indication of its ability to reproduce itself. With the lodgepole pine, the conception formed by the observer in the case of the lime-form would be that of a prolific seeder because of the fact that the cones of many different seed years are present on the branches. Another observer, taking his notes in a forest of the silica-form, in which the cones are not persistent, would very likely conclude that the species did not produce an abundance of seed. The two conceptions would be somewhat at variance, it is true, but this does not necessarily presuppose the existence of a great difference in the seed production of the two forms. Presuming that the seed years are of the same frequency in each case, any difference in the quantity of seed produced in a period of years would be due primarily to variations in the soil conditions and the available food supply, and the ultimate results, as far as the restocking of the area is concerned, might not be materially different.

Age.—In studying the life habits of a species, it is important to know, among other things, when the trees are likely to produce seed of good quality. In the case of the lime-form of the lodgepole, trees in the open with plenty of growing space begin to produce a few cones at the early age of six to ten years, but this cannot be taken as a true indication of the reproductive capacity of the species. When the principal height growth and especially the principal growth in volume are about completed, and the crown begins to broaden out, the stage has been reached when the conditions are most favorable for the production of seed. From a study of the lodgepole in the lime-form, it was found that the principal height growth was about completed at the age of one hundred years, and according to this general law the best quality and greatest abundance of seed would be produced at that stage.

In advocating the use of the clean cutting system in strips, Hodson makes the statement that " the solid strips should not be cut until the reproduction on the cleared strips has reached the seed-bearing age, which is usually at twenty to forty years of age." If the trees produce seed in sufficient abundance at that age to insure good restocking, it certainly will simplify the management. It is doubtful if any great quantity of seed would be produced at that time, and the same writer is authority for the statement that an abundance of seed is one of the requirements for insuring good reproduction.

A stand at twenty to forty years is still in the pole-stage, or at the best has hardly more than passed it, and if the stand is fairly normal as to the number of stems per unit of area, neither the condition of the stand nor the development of the trees is such as to meet the requirements for the best production of seed. The trees are far from having reached their principal height growth, the crowns have had no chance to broaden out, and no food material can be stored up preparatory to the production of seed because the growth activities require all that can be supplied. It is doubtful, therefore, whether an average stand of this age would produce sufficient seed to insure good reproduction.

Production of Cones.—Brief mention might also be made of the production of cones, which occurs with unusual regularity in the lime-form during the stage of best seed production. In collecting a small amount of cones for experimental purposes, it was found that in a period of fourteen years, there was only one year in which cones had not been produced. On the branches the cones are usually produced in pairs, although clusters with as many as six or seven will be found occasionally. On the main stem, the production of clusters containing three and four ounces occurs frequently.

Persistency of the Cones.—A hint as to the length of time the cones remain on the tree has already been given. The persistency of the cones is a characteristic of the species, which varies greatly in the two forms. In the silica-form, the cones drop off within a very short time after maturing, while in the lime-form they remain on the tree for long periods. Cones, respectively, twenty-two, twenty-five, twenty-seven, and twenty-nine years old, which showed no indication whatever of the scales parting, were found on the limbs, and cones thirty years old were found on the main stem of the trees. In another instance, cones were found on the bole of the tree which had been produced sixty-eight years previous to the date of collecting, but with these the scales had begun to separate to some extent.

This persistency of the cones in the lime-form is an interesting feature in more ways than one. When the cone is produced it is of course attached to the wood tissues of that year. On the limbs where the annual production of wood is very small, not only do the cones retain their connection with the parent wood for twenty years, and sometimes even for thirty years, but they remain so firmly attached that the branches become flattened by the pressure against the base of the cone. On the main stem of the tree, the production of wood is so much greater that it very soon forces a separation of the cone from the parent-wood, and we would naturally expect these to fall early; instead, however, they are likely to remain on the tree a long time, as has already been noted, being pushed farther and farther from the center as the stem develops, tracing the line of their progress by the small hole in the wood caused by the stem of the cone. The persistency of the cones which have become detached from the parent-wood is largely due to the pressure exerted by the growth activities of the cambium, and quite a little twisting and pulling is necessary to free them even in the case of those twenty-five and thirty years old.

Production of Seed.—Whatever importance attaches to the production of cones, and their persistency on the trees, in the final analysis, the items of vital importance in natural regeneration relate to the seed, its production, dissemination, and germination. Although in the lime-form, it was found that cones were produced yearly with great regularity, this feature cannot be taken as a true indication of the reproductive capacity, even assuming that the amount produced each year was practically the same.

An investigation was made to ascertain the relative production of seed of the lime-form in the following manner: Nine different lots of cones, each of different age, were taken and the number of seed carefully counted in about thirty cones in each lot. A summary of the results is presented in the following table:

NUMBER OF SEED PER CONE FOR CONES PRODUCED IN A SERIES OF YEARS

Year	1903	1902	1901	1900	1899	1898	1897	1896	1895
Age of cones	1	2	3	4	5	6	7	8	9
Age seed mature		1	2	3	4	5	6	7	8
Av. No. seed to cone....	10.4	4.8	13.9	15.7	16.4	9.4	16.4	15.5	13.5

The investigation was too limited in its scope to warrant making any definite conclusions, but the results are interesting in showing the probable existence of a certain periodicity in the seed production. The averages also indicates another characteristic of the species that greatly enhances the reproductive power of the lime-form, and that is its exceptional power of storing up reserve food material for seed production. In the first place, there are probably very few species which produce seed annually for as long a period as that represented in the table. According to the results as tabulated (reading from right to left) the species in the lime-form produces a fairly uniform amount of seed for three successive years, and then, with only a partial cessation of the seed production, again repeats a similar degree of production, followed by another partial cessation. The influence of the climatic factors should, of course, not be overlooked.

Dissemination of the Seed.—In the dissemination of the seed, the factors of chief importance are wind and fire. With the silica-form, where the cones open shortly after maturity, the first-named factor is primarily important because of the relation it bears to seed dispersal, fire being a secondary consideration. In the lime-form the conditions are reversed, fire being of primary importance, and the wind a factor which may have only a secondary influence, or even none at all. With cones of this form, the fact that heat is a very effective means of opening them offers the best explanation for the excellent reproduction which has quite often followed a fire in the forest. The degree of heat required to open the cones, hitherto a matter of conjecture, was made the subject of an investigation, the results of which are briefly summarized below.

The temperatures at which the cones were treated differed by five degrees, and varied from 45° to 100° C. To begin with, a few cones were tried at 40° C. in an oven where the temperature was regulated automatically. At the end of fifteen hours, the cones showed no signs of opening. At 45° C. (113° F.), six hours was required to open the cones. A temperature of 65° C. (149° F.), opened the cones well in forty minutes, and a temperature of 70° C. (158° F.), in thirty minutes. At 100° C. they opened in ten minutes. Solar heat in connection with a glass-covered box is also a good means of opening the cones when a temperature of at least 60° C. can be secured.

The experiment was also tried to see what the effect would be with cones placed on the ground. Six cones were tried in this way. In eight days one was well opened, and a slight parting of the scales was evident in the case of another. In seventeen days two were well opened, one fairly well, two showed signs of opening, and one had not yet begun to open. The results of this experiment demonstrate that the cones will open on the ground, and that fire is not, therefore, absolutely necessary to cause a parting of the scales.

Germination—the Effect of Heat.—Following the experiment with the different temperatures in opening the cones another was undertaken to see what effect similar temperatures would have on the germinating quality of the seed. The drying oven in which the cones were heated was brought up to the desired temperature before placing the cones in it, this method of procedure being adopted in order to make the conditions as nearly similar as possible to what might be expected in the case of a fire in the forest. The cones used for the experimental work were five years old, the seed obtained from them being four years old. In all the tests noted in this article, the seed was sown immediately after being removed from the cones. The test of the seed from cones subjected to different temperatures is presented in the following table:

TEST OF SEED SUBJECTED TO DIFFERENT TEMPERATURES (FLATS)

Temperature. Degrees.		Time heated.	No. seed planted.	Number germinating.	Per cent. germinating.	No. days until first germination.	No. days until last germination.
C.	F.	h. m.					
45	113	12.00	30	6	20	88	130
50	122	4.00	56	13	23	21	120
55	131	1.45	46	13	28	16	121
60	140	1.30	19	6	32	14	94
65	149	1.00	62	17	27	61	112
70	158	1.00	56	21	38	39	113
75	167	.40	34	5	15	13	111
80	176	.30	54	11	20	72	122
85	185	.30	36	4	11	78	100
90	194	.30	24	3	13	68	90
95	203	.20	50	15	30	17	119
100	212	.20	50	8	16	13	81

Another test along the same line was made with seed of the same age, to see what the effect on the germination of the seed would be when heated for different lengths of time at a given temperature. The results of this experiment appear in the following table:

TEST OF SEED SUBJECTED TO A TEMPERATURE OF 65°-70° C. (149°-158° F.) FOR DIFFERENT LENGTHS OF TIME

Time heated. Hours.	No. seed planted.	No. germinating.	Per cent. germinating.	No. days until first germination.	No. days until last germination.
2	34	15	44	41	100
3	44	22	50	61	110
4	53	32	60	25	100

These tests show that the vitality of all the seed is not destroyed when exposed to the higher temperatures for a short time only, and furthermore, that a fairly high temperature continued for some time seems to increase the per cent. of germination.

The Relation of Age.—Another factor of importance in the natural reproduction of a species is the length of time that the seed retains its vitality, for the longer it remains good, the more assured is the reproduction. Three tests were made in which the primary object was to ascertain what effect age has in modifying the germinating quality of the seed produced in the closed cones of the lime-form. The first test was made during the summer of 1905 following the collection of the cones the preceding fall. The seed, extracted by means of solar heat at a temperature not exceeding 63° C., was divided into three lots and sown in a nursery bed.

A summary of the test appears in the succeeding table:

RECORD OF GERMINATION TEST OF SEEDS OF DIFFERENT AGES (NURSERY BED)

Year cones produced.	Age.		No. seed tested.	No. seed germinating.	Per cent. germinating.	Average per cent. by periods.	Average number days until first germination.	Average number days until last germination.
	Cones.	Seed.						
Young trees.			75	16	21		25	106
1903	1	Mature	250	58	23		21	87
1902	2	1	250	87	35		22	72
1901	3	2	200	41	21		21	36
1900	4	3	250	87	35	28	22	91
1899	5	4	250	54	22		23	104
1898	6	5	250	68	27		22	86
1897	7	6	250	69	28		23	88
1896	8	7	250	54	22		23	72
1895	9	8	250	63	25	25	23	89
1894	10*							
1893	11	10	100	24	24		21	47
1892	12	11	250	57	23		22	76
1891	13	12	250	60	24		23	90
1890	14	13	250	53	21	23	23	74

* No. cones ten years old.

The second test was made nearly three years after the cones were collected. The cones were treated in a drying oven at a temperature of 65°-70° C. (149°-158° F.) for two hours, the germination test being conducted in greenhouse flats filled with soil. The test is not quite so complete as the previous one, because only a limited supply of cones remained after the seed was obtained for the first test. The results are given in the next table:

RECORD OF GERMINATION OF SEED OF DIFFERENT AGES (FLATS)

Year cones produced.	Age of cones.		Age seed tested.	No. seed tested.	No. germinating.	Per cent. germinating.	No. days until first germination.	No. days until last germination.
	When collected.	When opened.						
1903	1	4	3	58	16	25	49	104
1902	2	5	4	51	2	4	75	108
1901	3	6	5	50	2	4	75	105
1900	4	7	6	50	11	22	49	96
1899	5	8	7	46	11	24	49	115
1898	6	9	8	47	10	21	72	88
1897	7	10	9	56	12	21	51	115
1896	8	11	10	50	19	38	22	89
1895	9	12	11	50	20	40	66	96

In this test, the flats were out of doors for a part of the time and inside for the remainder. The unfavorable conditions prevailing during the time the seed was out of doors is the chief reason for the difference in time of the first and last terminations in the two tests. No explanation can be offered for the low germination which was obtained in two instances. The results of the two tests show that seed that has been preserved in the closed cones eleven and thirteen years germinates as readily as seed of more recent production.

The next table is interesting in showing how well the closed cones of the lime-form preserve the vitality of the seed. In this test, the cones were opened in a drying oven at a temperature of 65°-70° C. (149°-158° F.) maintained for one hour and thirty minutes. A moist chamber was used for the germination. In order to partially bridge over the gap represented in the age and have some kind of a basis for comparison, seed of the same lot as the oldest tested in the preceding experiment was tried at the same time.

RECORD OF GERMINATION TEST OF OLD SEED

Year Cones Produced	Age cones		Age Seed Tested	No. Seed Tested	No. germinating	Percent germinating
	When Coll.	When Opened				
1895	9	12	11	35	11	31
1883	21	24	23	32	16	50
1879	25	28	27	27	6	22

Natural Restocking.—The germination tests that have just been discussed are all for seed produced by the lime-form, no opportunity having presented itself to test the germinating quality of the seed of the silica-form. In the light of what has been said, it seems to me it is only reasonable to expect considerable variation in the ability of the two forms to restock an area, aside from the variations conceded to differences in the factors of locality. For one thing, even assuming that the quantity of seed produced by the two forms was ultimately about the same for trees or stands which had reached the period of best seed production, the accumulated seed crop of many years in the case of the lime-form makes a large amount of seed of fair germinating quality available for restocking, and gives it a decided advantage over the silica-form. This feature of the lime-form is a factor of considerable importance in the natural regeneration and one to which due attention must be given in the management of the forest. On the other hand, the absence of this feature in the silica-form is equally deserving of attention if successful regeneration is to be secured. Further, the conditions of the trees in regard to seed production should not be overlooked, for we can hardly expect a stand during the period of rapid growth to produce sufficient seed for restocking an area, even though this species begins to produce seed very early under some conditions. Then, too, there is the question of fire in its relation to the reproduction, and so far the evidence seems to be that it is beneficial in removing the generally light accumulation of duff and thus preparing a good germinating bed for the seed. This applies to both forms, and the writer's study and observation leads to the belief that in the silica-form it is otherwise not a factor of material importance. In the lime-form, however, fire is a much more important factor in natural regeneration, the thick young growth which often follows a burn being good evidence of this, yet fire is not always necessary, for the cones will open in contact with the ground as shown by the previously described experiment. The character of the fire would also modify the conditions, for in the case of slash a ground fire would cause the opening of the cones, while a hot crown fire would be required in the case of standing timber.

Without considering the influence of the factors of locality, different reasons may be assigned for the unsatisfactory reproduction on many cut-over areas. Grass is more or less abundant in the ground cover of the forest, and quickly forms a heavy sod on the cut-over areas, especially on limy soils, thus interfering with the growth of the young seedlings in the critical period immediately following germination. Again the forest might not have reached the period of best seed production when the cutting was made, and, further, fire is helpful in many cases as an agency in preparing the soil for the seed.

A satisfactory reproduction must, of course, be the first consideration in any plan of management. There is, however, some difference of opinion as to what scheme will best secure this result. Hodson says that plenty of light, plenty of seed, and a mineral soil are the silvicultural requirements which bring about effective reproduction, these being obtained when a mature stand is burned over. The conditions which he mentions would be secured easily in the lime-form when the area is burned, but are not as fully met in the silica-form where the cones open early and soon fall, thereby limiting the quantity of seed as compared with the lime-form. It is necessary, therefore, in the management of the lodgepole forests to take into account the difference in the two forms and regulate the cutting accordingly. In discussing the regulation only the pure stands of each form are considered.

Forests on Siliceous Soils.—Considering first the forests on siliceous soils, the following factors influencing the reproduction can be mentioned:

1. Cones opening at maturity or very shortly afterwards.
2. Probable yearly production of seed.
3. Distribution of seed by wind.
4. Best reproduction on a mineral soil.

For this type of forest, the system of clear cutting in strips is the method which appeals to me as deserving of first consideration. With this system, seeding from the side can be expected in the forests of the silica-form, and for best results the width of the strips should not be much greater than twice the average height of the seed-producing trees in the adjacent stand. The burning of the brush may be desirable as a precautionary measure against fire and insect pests. It would also be beneficial in exposing the mineral soil for seed germination, but aside from this, would have no influence on the reproduction.

Forests on Lime Soils.—In the case of forests growing on soils rich in lime, the factors of influence relative to the reproduction can be enumerated as follows:

1. Cones not opening at maturity, the crops of many years persisting on the trees.
2. Yearly production of cones.
3. Cones opening when heated, or when in contact with the ground, or possibly when near to the ground.
4. Vitality of seed preserved for a long time in the closed cones.
5. Best reproduction on mineral soil and following a burn.
6. Wind not a factor in seed distribution so far as the management is concerned.

Regeneration of this type of forest involves different considerations. The system of clear cutting is the best to use in the lime-form, except that it need not be limited to narrow strips as in the case of the silica-form. So far as the regeneration of the forest is concerned, the area clear-cut may be of any size or shape compatible with the local conditions. *Clear cutting in strips in the lime-form will not facilitate the regeneration of the area, as in the silica-form, by seeding from the side,* because the factors of seed production and distribution are different.

Another method that can be employed to good advantage with the lime-form is the system of successive cuttings. With this method, cuttings would be made over the whole forest or a given area from time to time as required. Such a method would not result, however, in a uniform regeneration of the forest over the whole area by seed dropped from the standing trees, as would ordinarily be the case. The only object which would be attained would be to improve the conditions for the production of seed until the period for the final felling, when all the trees were removed. The objection to this system is the danger of windfall, which has proved to be a serious obstacle to the use of the selection system in the lodgepole forests in certain localities. This I do not believe, however, will prove to be of much consequence in forests of the lime-form because of the fact that the trees develop a strong tap-root. In my own experience, I have seen young stands hardly more than past the pole stage which had been severely thinned where very few trees were blown down by the wind.

The cutting itself does not constitute the final step, whatever method may be employed. The burning of the brush is another problem to receive attention, the manner in which the refuse is handled, and the time when the burning is done, both being important. When the final cutting is made, ***the brush and tops should not be piled for burning,*** the aim being rather to have such materials as evenly distributed as possible over the area under the conditions governing the logging operations. It may be necessary, also, to lop some of the branches in the case of large tops to secure more effective results when the burning is done. The area is then burned over at some suitable time, primarily for the purpose of opening the cones for the liberation of the seed. It also prepares a good germinating bed for the seed by exposing the mineral soil, and if successful, would, of course, effectually dispose of the refuse.

From the results of the experiment where the closed cones were placed on the ground, it is reasonable to presume that those which come in contact with soil in the course of the logging operations will open, and the restocking of the area be obtained without the necessity of burning. But effective reproduction does not seem to be secured, if the scattering growth which has followed logging on areas not afterwards burned can be taken as an indication. This may be on account of the poor germinating bed, and also because comparatively few cones open in contact with the ground. Then, too, the poor condition of a stand in regard to seed production must be considered.

As previously stated, the time when the burning is done is another important point. The two seasons of the year in which this can be done are spring and fall, the choice being governed by local conditions. One thing in favor of fall burning is that nature's methods can be more closely followed. Seed falling to the ground at that time of year stands a good chance of becoming imbedded in the soil by the freezing and thawing, and by the soil wash from rains and melting snows. The seed lies over until the next spring and is then in a good condition to germinate readily and quickly, with the result that seedlings have a much better opportunity of getting their root systems well established before the advent of dry weather. The spring burning is all right as far as the actual disposal of the brush is concerned, but it seems to me that it is much more objectionable from the standpoint of reproduction. Unless the burning can be done immediately after the snow melts, there is the possibility that the work will have to be deferred until after the heavy spring rains. In the latter case, the germination of the seed and the chance of the seedlings surviving are much more doubtful, for, under the most favorable conditions, the seed lies in the ground two weeks or more before germination begins, while another month is required for the major portion to germinate. There is, therefore, less possibility of the seedlings getting their root systems well established before the dry season begins, with the result that their future existence becomes much more precarious. Furthermore, the heavy lime soils become crusted on drying, and would seriously interfere with the proper germination of the seed. This is not likely to happen in the case of fall burning, because the seed will have a much longer time to germinate, and with the cotyledons once above ground, the crusting of the soil is not then such a serious matter.

The writer is not unmindful of the fact that the problem of burning the brush is one much easier in the telling than in the execution, and that it has its objections. This feature of the management should be carefully considered, however, because the future forest of the lime-form depends so largely, if not entirely, upon this one operation. If a failure results, and the area is large, there is then no other expedient, from an economical point of view, than to replant. If the natural regeneration which so commonly follows a fire in the forests of the lime-form can be taken as a criterion, the method suggested for burning the brush should give good results in the way of satisfactory reproduction, and furthermore will be attended with less uncertainty than the regeneration of the forest on sandy soils.

In the meager consideration of the management features just recited, the discussion has been limited to the two extremes of soil characteristics, which produce the silica-form of forest in one case; and the lime-form in the other. Variations in the lime content of the soil between the minimum of the siliceous soils and maximum of the lime soils, may make certain modifications advisable, but should not necessarily introduce a factor that will complicate the regeneration of the forest. The management of the forest to secure reproduction would be governed simply by the one factor of whether the cones remained closed on the trees or opened when mature, a feature which can be easily ascertained.

The suggestions that have been made may seem to be of an ideal character, especially when no effort has been made to consider the variations in each locality, which result from physical features of slope and elevation; climatic factors of rainfall, temperature, and winds; market conditions affecting the logging operations and also the supply and demand; and the variations in the character of the forest which influence wood production and the yield of seed. Each of these factors introduces a different feature which must be given due consideration in the solution of the problem.

Let it be stated in addition that the subject-matter as presented is based upon studies and investigations of a preliminary character only, but it is hoped that it will prove helpful in solving the perplexing problems involved in the management of our lodgepole pine forests.

PRELIMINARY FOREST MANAGEMENT IN THE SOUTHWEST

THEODORE SALISBURY WOOLSEY, JR.

Contributed

Some of the most important problems that have confronted the Forest Service have been the regulation of the annual cut, the establishment of minimum stumpage rates, and the drawing up of a definite forest policy for each forest. On account of the comparative scarcity of the timber supply these were particularly important in the Southwest. The subject has already been discussed before the Society along broad lines and, hence, it seems particularly opportune to take up in some detail the actual working out of policies in one of the districts.

On the eighteen forests in Arizona and New Mexico, the total estimated stand only amounts to 16,394,270,000 feet B.M., and 29,947,300 cords. Even under present conditions the natural growth is undoubtedly insufficient to supply the local needs; with the increased demand that is sure to come, since settlement has scarcely begun in many portions of the Southwest, it will fall far short in the future. Consequently, a conservative forest management skillfully carried out from the start is absolutely essential. In many localities where mining and the lumber business now flourish, if the present scale of cutting continues, ten years hence towns that are now flourishing will be deserted, as was the case in Michigan and Minnesota when lumbering was extensive in those States.

One of the first points to consider in the sale of timber is naturally the prices that should be charged, since in most timber sales the established minimum price given in any advertisement is usually the price at which the timber is sold. Theoretically there is always competition when timber is advertised, but practically there is usually one company that controls the situation. Consequently, the minimum rate established by the Forest Service is of particular importance, since usually it is the rate at which the timber is sold. In comparing the prices charged on neighboring forests it was very evident that they were not consistent and the personal characteristics of the officer in charge often decided whether the prices for the different classes of material should be high or low. For example, on the Lincoln the price for fence posts was three cents each, whereas on the Alamo it had been advanced to five cents. Since these two forests adjoin, these varying prices naturally excited considerable dissatisfaction; the prices on neighboring forests should be harmonious.

It may be interesting to review the policy which governs Government stumpage rates in this district. While minimum rates have been established for each forest they are considered strictly as minimum, and higher rates are expected for the better classes of timber. Before a price lower than that established is made the local officer is required to submit an explanation, and since the district office has a record of every sale, however unimportant, a very exact check can be kept to insure that the proper rates are being charged.

The use of less valuable species if at all suitable is insisted upon, and every sale area is supposed to include all merchantable species even if inferior. The same price is ordinarily required in saw-timber sales for both dead and green material, and also as a rule for dead and green fence posts, poles, lagging, and fence stays. The underlying principle for this policy is that, while the dead material may be slightly inferior, yet it is usually merchantable ·under the contract. Quite recently in saw-timber sales it has been customary to insist that all dead timber be felled whether merchantable or not. But, of course, only the merchantable portions need be logged and paid for. This insures very complete utilization. In the sale of cordwood, however, a separate price seemed desirable for dead and green material. It is particularly essential that sales be made for dead material alone, since this class of fuel rapidly deteriorates and should be utilized as soon as possible. On account of its being scattered over a greater area it is naturally more expensive to cut, and therefore justifies a lower price.

In determining the price for saw logs the standard was set by the prices secured in advertised sales where the competition had properly regulated the rate.

Fence posts were considered of practically the same value over the Southwest. Very few are commercially exported but rather are used locally by settlers. Since a dead post is worth as much as a green one, one price was made. Where posts are longer than seven feet an extra charge of one cent a linear foot has been made. This is very low in comparison with the sale of yellow pine for poles by the linear foot, but it seemed particularly desirable in order that settlers could obtain material necessary for improvements on a very liberal valuation.

In the past poles had been sold by the piece without reference to length, and prices have greatly varied. It is moreover seldom advisable to cut poles in yellow pine and associated species, and therefore their use should be discouraged. For this reason a rather high rate has been in force exclusively on the linear foot valuation. The rates are approximately one-third more than are charged for ordinary saw-timber. Fence rails, if split from dead yellow pine and unfit for saw-timber, may be sold by the cord; but as a rule poles are only sold from dead insect-infested or otherwise deteriorating timber or when thinnings can properly be made. Lagging has been sold by the cord, by the board foot, and by the piece, but it seemed advisable to narrow this down to a sale either by the piece or by the board foot, and a payment for the entire tree felled is insisted upon.

As an illustration of minimum stumpage rates the following prices established on the Magdalena Forest are given:

Saw-timber (Green and Dry)	$4.50	per M. ft.
Cordwood (Green)	.75	per cord
Cordwood (Dry)	.40	per cord
Fence Posts (Green and Dry)	.05	a piece
Poles, etc. (Green and Dry	.025	per linear ft.
Fence stays (Green and Dry)	.01	a piece

Once the problem of minimum stumpage rates was settled it seemed essential that a rough scheme of forest management be established for each forest. In establishing such a policy several questions arose. In order to have a proper check on the sale of timber it seemed best to establish a limitation of annual cut both for cordwood and for saw-timber. If a timber valuation alone had been established the aggregate cut might not have been exceeded, and yet the timber resources as opposed to cordwood supply might have been rapidly depleted without its being known. Another point emphasized was the actual amount of timber or cordwood that would be available for timber sales. It naturally would not be fair to include as live capital timber that was needed for protection or was so inaccessible that it could never be logged. Therefore, only the available timber supply was considered in drawing up the limitation for an annual cut.

It seemed necessary to recommend definite areas where cutting should be encouraged, and also areas and types of timber where no cutting should be allowed. In the yellow pine belt no healthy "black jack" (young yellow pine) are cut except where in need of thinning. Not more than one-third the original stand is marked for cutting. Where the stand is less than two thousand feet per acre, no cutting whatever is allowed except of very defective or insect-infested timber. This automatically provides that there shall be no cutting in yellow pine bordering the woodland type, since these stands are almost universally less than two thousand feet per acre. On almost every forest it was deemed inadvisable to make more than an improvement thinning on steep ridges and hill tops.

Where the timber is limited, in order that the local residents should be provided for first, certain areas are reserved exclusively for free use or for small sales.

In establishing a limitation for an annual cut some simple method had to be adopted that would be immediately effective. Accordingly Von Mantel's simple but not altogether accurate method has been followed in estimating the annual growth. Since the forest capital has not been reduced to normal on most forests, this method seemed well adapted to all practical requirements. It will add to the actual growing stock if it is below normal, while if it is above normal it will be automatically reduced. At present the rotation is not a financial one but technical; in other words, the rotation is designed to produce a good quality of saw-logs instead of the greatest possible output. A rotation of two hundred years for yellow pine and one hundred and fifty years for the woodland zone was provisionally established. According to this method one per cent. of the available yellow pine stand and one and three-tenths per cent. of the woodland stand may be cut on each forest. At present the limitation is very broad and is not differentiated for each particular watershed, but, of course, it will be extended as definite figures are collected by reconnaissance parties. Where the annual cut amounted to such a small figure as to prevent successful logging, the local officer was authorized to save up his annual output and make periodic sales of a commercial size.

Taken as a whole the policy established has been one of extreme conservatism, and has aimed primarily to hold the timber for local use and to favor local industries as far as possible.

The actual preliminary sales policy put into effect on the Magdalena Forests follows:

Preliminary Sales Policy. Magdalena Forest. September 1, 1908.

1. Available growing stock..	44,999 M. ft. B.M...	560,000 cords
Protection forest, etc.....	83,571 M. ft. B.M...	840,000 cords
Total stand estimated....	128,570 M. ft. B.M...	1,400,000 cords
2. Maximum annual cut....	449 M. ft. B.M...	7,466 cords
Per cent. of est. available stand	1	1.33

3. Immediate cutting: No areas known.

4. Policy for future sales: In the Magdalena Mountains free use only should be allowed. In the San Mateo mountains, east of approximately range six west free use and local sales, with provision that not more than ten per cent. should be exported from Socorro or Sierra Counties.

The first criticism of this rough preliminary working plan is that it does not go into detail and that it is too simple. The writer believes, however, that, at the start, simplicity and practicability are the first requisites in establishing technical forestry; which will be followed up later by detailed working plans. I have merely outlined this important subject to give an insight into the crude methods now in use; later they will be improved upon and exemplified.

As rapidly as possible it is aimed to estimate in detail each forest and to draw up a preliminary working plan that will compare favorably with the detailed supervision that is secured in older countries. The feature of this new reconnaissance will be its adaptability for American conditions. Already in the Southwest one detailed working plan has been completed and two are under way. To secure the best results the fullest co-operation between the district offices will be maintained in order that these plans may be extremely practical and cover every branch of forest work.

One radical departure that will probably be made from European methods will be the annual revision of working plans instead of a periodic revision every five or ten years. This is necessary on account of the rapidly changing conditions and the impossibility of fully anticipating in advance the local requirements for forest management. One of the features of the future growth determination will be the measurement of sample plots on cut-over areas in order to predict the yield more accurately. Already some five thousand acres on the Coconino have been measured and estimated and the actual growth will be accurately known when these plots are re-measured at the end of five years. The first measurements were made by the writer in 1905.

Ten years from now this pioneer technical forestry may be ridiculed but it is certainly true that *results* can be best secured by actually making a beginning, even if mistakes occur which have to be corrected in later work.

TIMBER ESTIMATING

HERMAN HAUPT CHAPMAN

Contributed

The contents of standing timber cannot be determined with absolute accuracy until it has been cut and measured. It is best, when timber is to be cut immediately, to base its sale upon the measured contents after cutting. But in most transfers of timberland its valuation must be based upon an estimate of the contents of the standing timber, which will vary more or less from the truth according as the work is thoroughly and accurately or hastily and carelessly done.

Much mystery has surrounded the methods of the timber cruiser, chiefly because his main asset is his judgment and experience and he is not given to revealing his methods or possible lack of system, but relies on his reputation and is seldom known to change an estimate once submitted.

Timber must be estimated in the unit of products into which it is converted for immediate sale. As most of our more valuable timber is intended for lumber, the saw-log is the form in which the timber is measured when cut. The different log rules, used in measuring the supposed contents of logs in board feet, do not give accurately the output of lumber. There will be an overrun in nearly all instances, whose size will vary with the rule used and with the methods employed in sawing the logs. This overrun must be entirely neglected in estimating the timber, since it is the scale of the log which determines the contents accepted by the purchaser and the logging contractor, and the estimate must agree with this standard of measurement. The differences resulting from the use of different log rules may be as great as twenty-five per cent.

Timber must be estimated on the basis of the proportion of the stand which will be utilized. As prices increase, smaller trees are cut, the tops are taken to smaller diameters, and more of the knotty or defective logs can be removed at a profit. On the Pacific Coast, and in some portions of the South, there is still a great waste. Estimates cannot anticipate a much closer utilization than that which is at present possible in the region, and old estimates will therefore become inaccurate as logging methods change.

While the most common unit of estimating is the board foot, it is often necessary to substitute such other units as the cord, the tie, pole, or post, when the timber is to be used in these forms. These requirements will account for much of the possible variation in timber estimates. But much greater variations may arise from the use of inaccurate methods or from lack of judgment and skill on the part of the cruiser.

The oldest and simplest method is that of guessing at the total contents of the entire stand, with no attempt to check one's figures by measurements. When a woodsman becomes familiar with the appearance of timber in his neighborhood and has seen tracts lumbered and knows what they cut, he can turn this knowledge to good account in guessing at the probable cut of similar tracts. Training thus acquired is useless except for a limited region, and the results, even from the most experienced woodsman, will not be consistent, but will be unduly influenced by the weather and the physical condition of the cruiser. Formerly, when much timber was bought by the acre, or at a low price per thousand feet, such a method was serviceable. The cruiser had only to be conservative. From now on, estimates must agree more closely with the actual cut; and, while still conservative, should aim to come within ten to fifteen per cent. of the cut. A closer estimate will be difficult to attain by any practical method.

Since the total stand of timber on a tract is the sum of the contents of all the merchantable trees, systematic estimating consists in using the tree and not the total stand as the unit. The most accurate method is to determine separately the contents of every tree, just as in scaling one records each log. This would be possible only on small tracts with large and valuable trees. Owing to the necessity of doing the work far more rapidly than this method will permit, estimating usually consists of some modification in which only a small fraction of a tract is covered, and the accuracy of the result depends on obtaining an average which will apply to the whole tract.

This saving may be effected either by covering only a portion of the area, or by determining the contents of only a portion of the trees, or both. As a rule, timber cruisers have preferred to cover as much of the area as possible by counting all the trees and trust to an average figure for their contents, while foresters have determined more carefully the contents of a large number of trees but covered only a small per cent. of the total area.

With small timber it is impractical to count the entire stand, but with old pine or other large trees, a method commonly employed in the Lake States is as follows: The cruiser follows the boundary of the forty to a point twenty rods from the corner, then crosses to the opposite side, counting all the trees, as he goes, on one-half the forty. On his return trip he crosses the center of the other half. If the entire section is to be estimated, he will cross four forties before returning, and will complete the estimate of each forty on his return trip. It is possible to see and count trees for twenty rods on each side, but not always easy to do so when the foliage is on the brush in summer.

Another method of getting a total count is used when the cruiser has the aid of a compass-man. The latter crosses the center of the forty, while the cruiser, who, in certain parts of the South is mounted, goes back and forth on both sides of him in an effort to see all the timber. A count made in this way is apt to be a good deal of an approximation. Should the value of the timber warrant it, a forty may be crossed four times instead of twice, in an effort to count all the trees. This would be advisable in large timber with heavy underbrush. It is seldom that cruisers go more than twice across, under ordinary conditions.

There are great advantages even in a rough count which covers the entire area. Large timber is usually unevenly distributed and interrupted by openings, young growth, or burns and swamps. By a total count, the necessity of mapping areas, or of ascertaining the average stand per acre is eliminated, and there remains only the determination of the contents of the trees counted. Cruisers have learned that it is easier to approximate the average contents of trees than to get the average stand per acre.

The difficulty of covering the total area even by a mere count increases with smaller and younger classes of timber, and the necessity for it decreases as the tree unit becomes less valuable and the stands more uniform in density. But as soon as the method is definitely abandoned and only a portion of the area is covered, we are forced to one of the following courses:

a. To determine the total area accurately.

b. To cover a definite area or per cent. of total.

c. To determine the relation between the stand of timber on the portion estimated and on that not covered.

This is in addition to the determination of the contents of the trees as before. If one can be sure that the average stand per acre is the same on the rest of the tract as it is for his estimated area, the total estimate is merely this stand multiplied by the total acreage. Or if it is possible, in estimating a portion, to view the remainder and judge as to the relation which the stand upon that portion bears to the estimated area, a correction factor may be applied, by which the remaining stand may be obtained from that already found. The use of a correction factor, based on measurement of a portion of the stand, is really an attempt to see the whole stand, but to count or tally only a definite portion of it. One refuses to accept the tallied portion as an average, and raises or lowers his figures to accord with his observations. While this resembles the plan of guessing at the total stand, it is superior to it in that one has a large portion of the stand definitely measured, and has merely to judge the relation of the rest to this portion in terms of percentage. Again, as the correction factor involves the viewing of the whole stand, it very largely eliminates the risk that the portion measured will give false results by not indicating the average stand per acre.

In many cases there will be time for the measurement of only a small portion of the area, and as the rest is not seen, the average stand so obtained must be accepted for the whole tract. A wide latitude is given as to the per cent. of total area necessary to be covered to insure reasonably close results. The following rules are useful in this connection:

1. The smaller the area unit for estimates, the larger the per cent. that must be covered. Twenty-five per cent. for forty acres would probably give no closer results than ten per cent. for a section, or two and one-half per cent. for a township. This is due to the uneven distribution of most timber. Upon the larger unit these local variations are averaged, but on the forty most of the timber might be on one side and be missed altogether unless a much larger per cent. of area were covered. Since the smaller the area unit the more valuable will the figures be, even on large tracts, it follows that the purpose of the estimate

will fix the unit of area used, and this in turn will indicate the per cent. of area to be covered, and the consequent cost of the work.

2. Since slope and relative altitude, with its consequent heat and moisture relations, profoundly affect the height, density, and composition of the forest, the only safe way of getting a true average for the whole tract from a portion of it is to run the surveys across the drainage and at right angles to the prevailing contours, i.e., up and down slopes. In taking narrow strips and a small per cent. of the area this distribution of strips is increasingly important, and an attempt to run the surveys along bottoms or through definite types has frequently resulted in large errors.

3. As the size and value of the individual tree increase and the density and distribution of the timber become less uniform, the percentage of area covered must be greater to obtain an accurate average per acre. This means that a percentage of area sufficient for second growth hardwood, or even matured spruce, would be sufficient if applied in the same way to old white pine or virgin hardwoods. The method chosen for covering only a portion of the area may be either strips or plots. Ordinarily it is necessary to map types of timber, open lands, burns, and topography. All of the timber mapping and much, if not all, of the topography may be worked out in connection with the estimate if the strip method is used, and each strip is located by direction and distance from a base. The width of strip most used is four rods, but strips run twice across a forty will then cover only ten per cent. of this area. When a larger percentage is necessary it is better to take wider strips rather than to cross the forty oftener. Strips ten rods or even twenty rods wide are much better adapted to estimating pine timber than the four-rod strips, and with the twenty-rod width two strips will cover fifty per cent. of the total area. Since the error allowable is in proportion

to the width of the strip, a wide strip may be judged by the eye as accurately as a narrower one.

The plot is best used as a mere modification of the strip. The system consists in measuring plots of a given size at definite intervals in a compass course. When this is done, mapping is possible, and the choice of plots is made to depend on a mechanical location. The accuracy of the average stand per acre obtained for such plots depends on the percentage of the total area actually estimated in the plots. The most convenient plot is the circular one, one hundred and eighteen feet in radius, or in smaller timber the circular quarter acre of fifty-nine feet in radius, since one man can determine the boundaries of such plots by the eye from the center.

Should plots be located arbitrarily, in an effort to determine the average stand per acre, the results will depend as largely on the ability of the estimator to select average plots as upon the contents measured. The tendency is to overestimate the stand by selecting plots in timber of more than average density.

So far, nothing has been said about determining the volumes of the trees. Volumes in board feet are in practice based either on the contents of logs or of whole trees. Log rules are the tables used most widely by cruisers, since the contents of logs as shown by rule is the information most easy to obtain. Volume tables showing the contents of whole trees require a detailed study which the woodsman does not always make.

Using the log as the unit of contents a cruiser need only count his trees, determine the average number of sixteen-foot logs per tree, and decide how many logs will scale one thousand feet of lumber according to the rule he uses, getting the total estimate by multiplication. A modification of this system is the determination of the average contents of the trees counted, a figure obtained from a knowledge of the number of logs and their total contents in trees of different sizes. This is in reality a volume table carried in the cruiser's head in the form of impressions derived from his experience in scaling and in computing the contents of trees. Either of these methods is liable to serious error, and is especially difficult to apply properly in timber which varies greatly in size. But very good results are obtained by experienced men in their use, chiefly because they depend upon a full count, thus limiting the error largely to the one element of size of the trees counted.

The tendency of the more technically-trained forester, in estimating timber, is to determine accurately the contents of a large number of trees, and not trust to general averages for his volumes. But in doing this he is apt to confine his work to a small portion of the area, and run the risk of getting an incorrect average stand per acre. That system is the best which comes nearest to accounting for the whole area, and at the same time gets the largest amount of accurate information about the tree contents.

Of the factors which determine the volume of a tree, diameter is of the most importance; next height; and third, variation in form within the limits of equal diameter and height. Roughly speaking, a difference of one inch in diameter in longleaf pine will equal a difference of eight feet in merchantable height. If volume tables are prepared to show volumes for differences both in height and diameter, the variation in form will seldom affect the accuracy of the figures. The greatest difference will be found between old and young timber of the same size which indicates slow growth of the old timber. The young timber may have up to ten per cent. less volume than the old. The question whether, in classifying volumes, heights should be based on merchantable length expressed in standard logs, as sixteen feet, or on the total length of the tree, will depend upon the system to be used in estimating the timber. Volume tables based on diameter alone are worthless, since not even the crudest estimate can neglect variation in height. The merchantable length, and not the total height of a tree, will always determine the scaled contents. In timber of variable density and height, and with crowns which affect the used length by rendering a greater or less proportion of it unmerchantable, the number of logs used is probably the best basis for a volume table.

The cruiser has, then, the choice of several methods for getting the contents of his trees. If he is unwilling to risk his judgment as to the average contents of logs or of whole trees, he must resort to tallying enough individuals to give him the proper information. In the absence of a volume table he will use the log unit. This method consists in tallying the estimated upper diameter of each log in a tree, inside bark measurement. Familiarity with the average taper of different species is the principal need. If all the trees on a strip are taken, the method is slow, even for a strip four rods wide, but its distinct advantage is that the actual merchantable height of every tree tallied is recorded, thus giving an estimate in which no wholesale averaging is done either for height, diameter, or contents. In practice, the total estimate will be obtained by one of the methods of covering only a portion of the area, and seldom, if ever, by taking all the trees in a stand.

Where the tree unit is used and a large number tallied the volume table comes into play. The forester has the advantage over cruisers in that he measures the tree at breast-height instead of at an arbitrary stump-height, both because of the greater ease of measurement at that point either by eye or calipers and because of the more consistent volumes obtained for the same diameter. The great trouble with the use of volume tables is failure to ascertain whether the table really gives volumes which correspond to the results of logging in the locality. Unless a table is constructed for the log rule used in scaling, it will be comparatively useless without a complete revision. Differences in the closeness of utilization will affect the volumes given. In short, a volume table must be constructed for local application, otherwise its use has the same effect on the result as the use of a false standard of measure or weight. This article must confine itself to the application and not the construction of volume tables. In tallying trees, for the purpose of applying a volume table, the diameter is always taken at breast-height. But the method of tallying or determining heights is more variable. These must be obtained, since with both diameter and height known the volume of a standing tree is fixed within the limits indicated by a good table. The usual plan, however, is to measure a few heights in order to get the average height on a basis of diameter for the whole stand, or such part of it as may be estimated as one body. A curve of height on diameter assists in this determination. Should the forest be marked off into distinct enough types, which can be separated by area, a separate height-curve is used for each type. In such a system, good results are obtained if care is used in getting average heights and the forest is fairly regular in its growth.

The greatest amount of detail is obtained when the height as well as the diameter of each tree tallied is noted. This is practically the same plan as that used when every merchantable log is recorded, except that in using a volume table the field record requires making only a single mark or dot for each tree and calls for much less exacting work on the part of the cruiser—merely the measurement at breast-height, and the total height or merchantable height.

The choice of a system of estimating will depend upon the following considerations:

1. The experience and judgment of the cruiser.

2. The purpose of the estimate and need of accuracy, i.e., closeness of estimate desired.

3. Time and expense allowable for completion of the work.

4. Character, size, and uniformity of the timber, and conditions of topography and underbrush.

The elements of estimating may be summed up as follows:

1. Guessing at total stand versus using the tree unit.

2. Counting or tallying the total area versus covering only a portion of it.

3. Averaging the contents by guess versus tallying a large number of trees to obtain this average.

4. Using the log as basis for volumes versus a volume table for whole trees.

5. Tallying diameters only, with heights obtained from averages, versus tallying both diameters and heights.

6. Tallying for diameter or height every tree actually counted versus counting a large number and tallying the dimensions of a lesser percentage.

With these summaries in mind, a system of estimating can be devised to fit any special conditions.

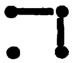
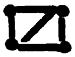
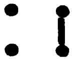
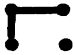
The attainment of accurate estimates on the National Forests suffers from two handicaps: First, the timber is sold on the basis of actual scale and not by estimate, thus making close accuracy unnecessary except as a convenience in laying out timber-sale areas. Second, in the case of estimates of entire forests, the area covered is large, and the purpose of the estimate—a summary of the total stand—does not demand extreme accuracy. We consequently find the Forest Service forced to abandon all forms of tree-unit estimating and to rely upon the system of crossing a forty once and guessing at the total stand. In practice, the judgment of the cruisers is checked by taking sample plots—usually at random. Greater care in detail, however, is exercised in making an estimate for a timber sale.

A system which serves to illustrate several features of estimating has been used for the last two years as a means of training the senior class of the Yale Forest School in the rather open longleaf pine woods of the southern States. The unit of area chosen was forty acres. Three men constitute a crew, one acting as compass-man, pacing distances, and sketching topography and timber types in a broad way. Two strips are run across a forty, the compass-man starting twenty rods from the corner and crossing the center of one half, then offsetting forty rods to return through the center of the other half. In practice, the crew estimates one-half a tier of four forties and completes them on the return mile. The other two men parallel the compass-man, one on each side at a distance of ten rods, and estimate the timber on this ten-rod strip, each man doing his own tallying. In this way two strips of twenty rods are covered, giving fifty per cent. of the area.

Upon the ten-rod strip the merchantable trees are all counted, but no attempt is made to tally them all. One tree in every five is tallied. In this way one-tenth of the merchantable stand is tallied, the measurements being based on an examination of one-half the stand. In tallying the fifth tree, it is the rule to select each time the one nearest at hand, thus making the tally mechanical and avoiding the tendency to select by eye the supposedly average tree of the five. It was satisfactorily proved by actual tests that this method of tallying results in a high degree of accuracy.

The basis for volumes is a local volume table prepared from a study of tapers on five hundred trees, showing volumes by diameters and sixteen-foot lengths and half lengths. Longleaf pine varies greatly in height for the same diameters, on account of uneven density and differences in elevation and soil moisture. In making the field records, therefore, the merchantable heights as well as diameters are recorded in the following form:

SPECIES—PINE

D. B. H.	1 log.	2 logs.	2½ logs.	3 logs.	Etc.
12	● ●				
13	●	● ● ● ●			
14			● ●		
15		●		●	
16		●			
Etc.					

Both diameters and heights are judged by the eye, but calipers are carried as a check. Such a tally involves some labor in computing volumes—which is the chief objection—but, as only one-tenth of the trees are considered, the final total is obtained by adding the cipher. Since so many heights are recorded, the estimate will be quite close, no matter how wide the fluctuation in height caused by varying type or density. It is, therefore, especially adapted to irregular stands where height is an important factor. While but fifty per cent. of the area is actually counted, each cruiser, working from the edge of his strip, has an opportunity to see all of the timber not tallied. If necessary, he can apply a correction factor to his estimate in order to make it conform to the conditions of the entire forty.

If the mapping is done rapidly, a crew of three men can cover twelve forties per day by this method.

Numerous illustrations could be given of modifications necessitated by conditions. One man working alone can apply the above system by counting to ten rods on each side of his compass course and tallying every fifth tree, doing his pacing and counting alternately. He would probably not see more than half the area unless he ran four strips. If the cruiser does not desire to tally a portion of the stand, he falls back on his ability to average the log-run and heights or the tree contents. Of these two alternatives, the first seems to give the closest results—but in any case the cruiser would, in large timber, count as great an area as possible.

It is probable that foresters in the West will get better results when they can use the wide strip, or total count, rather than too small a percentage of area; and combine this with the preparation of local volume tables. With these tables as a guide to volume, and the total number of trees fairly well worked out, there remains to be found only the range and distribution of diameters and heights. It will hardly ever be necessary to measure more than a small fraction of the stand to secure these data. The point for chief care is to take the figures in such a way as to get a fair average. Every fifth tree in a twenty-rod strip is about the maximum needed. In much of the estimating in the West the unit of area is so large that the measurement of a large per cent. of the area is not justified, while at the same time the density of brush and timber, especially in northern States, prevents counting trees on a wide strip. This suggests the use of a four-rod strip, in which case the usual plan of measuring the diameter of every tree may be advisable. But even in this method, better results might be obtained by reducing the measurements on the strip to say one-half or one-fourth of the trees on the strip and counting the rest. This could be done by one man who, with a little training, might be able to estimate instead of measure the diameters of most of the trees. If he does his own tallying, the crew may thus be reduced to two men. Since the usual crew is four men, twice as many crews could be run, and twice as many strips covered. The advantage of this would probably more than offset the possible loss of accuracy in not calipering all the trees in the strip. As to the method of selection, one tree in four could be taken, or a definite number, say one hundred trees, counted, and then the next twenty-five tallied just as they come, a plan which might be preferable in a mixed forest.

The system of sample plots arbitrarily selected will find little practical application under western conditions, and, in the writer's judgment, should ordinarily not be depended upon.

In allowing for defects, local experience, especially in the mill, is indispensable, and must be acquired before one can hope to make the proper deductions in the woods. Volume tables should always be made for sound timber, giving the cruiser a standard from which to make deductions according to circumstances. With the ability to recognize the signs of defect in standing timber, and the knowledge of its probable extent, the cruiser may adapt such a method of deduction as best fits his system of estimating. One of the simplest methods is to omit the tally of defective trees or logs, or to make a reduction in the size tallied so as to record only the sound timber; or all merchantable trees may be recorded and a percentage subtracted from the total for defects.

Since the above discussion was written, the "Manual for Northern Woodsmen" by Professor Austin Cary has been issued. In his chapter on timber estimating, Mr. Cary covers the subject of timber estimating in such a complete and logical manner that the writer can hardly plead originality as an excuse for presenting this article, and takes a sincere pleasure in urging those interested in the subject to study and use that Manual.

DEPARTMENT OF DISCUSSIONS

Announcement

It has heretofore been the custom to publish in the Proceedings of the Society of American Foresters only the papers read before the Society. There have been no published discussions of the papers. Hereafter there will be in the Proceedings a department of " Discussions," designed not so much for a verbatim account of the discussions at the meetings as for written comments on the published papers and articles and brief discussions of the technical matters which the writers may not desire to present as formal articles. In the current number, for example, there is an inquiry from Mr. E. A. Braniff concerning certain technical problems which he has encountered in Wisconsin and a request for information from those who have had experience in similar forests.

It is hoped that the members of the Society will take advantage of this opportunity for public discussions of technical forest problems.

H. S. Graves.

A SILVICULTURAL PROBLEM IN WISCONSIN

On the Menominee Indian Reservation, Wisconsin, the hardwood timber is very liable to damage from windfall. The trees are long-bodied and shallow-rooted; and the forest being virgin, with a very high proportion of mature trees, a selection cutting, no matter how cautiously made, would be hazardous. The principal trees are maple, birch, elm, and basswood. The stand will average about nine thousand feet per acre. The ground is rolling, easily logged, without hills. Elm and basswood are particularly choice, and are abundant; the maple and birch are not of such high quality or nearly so valuable as the former. It is necessary to cut these hardwoods in such manner as to have reproduced the forest, or have provided for its certain reproduction, within the limited time required to log the old stand by railroad. In other words, since the forest must be logged by railroad, each cutting operation must be so timed and so managed that, when the main-line track has been taken up and moved, satisfactory reproduction shall have already taken place on the earlier cuttings and have been provided for in the later cuttings.

The system of cutting which seems best suited to the conditions is that of heavy selection cutting (nearly clear cutting in most cases) in strips or in spots, with virgin forest between, so as to lessen the danger from wind. These intervening strips of forest are to be removed just as rapidly as reproduction can be secured. The amount of track to be laid must be as limited as is consistent with the necessities of removing, say, ten to twelve million feet of green timber a year under the system outlined above.

Definite information is wanted on the following points:

1. The strips to be cut are to coincide with the main-line tracks, the loading tracks, and the logging roads that radiate from them. The spots are to be openings in the forest scattered between the strips and connected by logging roads. What shall be the maximum width, consistent with safety from windfall, danger from drying out of soil and change of forest conditions, etc., of the strips and other openings made? In this connection, remember that basswood and elm, both light-seeded trees, are the ones whose reproduction is most desired.

2. What will be the minimum time required to stock the openings by natural seeding; in other words, how long after the first openings are made will it be safe to widen these openings by further cutting?

3. To what extent, if any, will planting be required to

assist nature in obtaining reproduction in the limited time allowed between the laying and removal of the tracks? Assume that ten years is the maximum time the main-line track can remain.

The problem above outlined is an actual one, which must be met. The conditions are fixed and definite; no less definite is the fact that a rational forest policy must be worked out on the basis of such conditions. The information sought is therefore earnestly desired and will be put to practical use if it can be obtained.

A discussion of this problem is invited in the Proceedings of the Society of American Foresters.

E. A. Braniff.

Vol. IV No. [illegible]

Proceedings
of
The Society of American Foresters

1909

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WASHINGTON, D. C.
PUBLISHED BY THE SOCIETY
1909

Yale Publishing Association
(Incorporated)
New Haven, Conn.

PROCEEDINGS
OF
The Society of American Foresters

The publications of the Society are sent gratuitously to all members. Copies of the Proceedings may be obtained from the Secretary for 50 cents each number.

VOL. IV 1909 NO. 2

THE RELATION OF SURFACE CONDITIONS TO STREAM FLOW

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Presented before the Society March 26, 1909

Popular opinion for years has been that floods are increasing in frequency and duration in many rivers of the United States. Until within a year, however, there had been no careful examination of records to see whether or not the popular opinion is based upon fact.

About a year ago, it was thought worth while to look into the records, to see whether any changes were discernible. The results were surprising. It was found that in many of the streams which take their rise in the Appalachian Mountains, there has been a steady increase in the number and duration of floods during the past twenty or thirty years.

It is true that in certain rivers an opposite tendency is to be seen: floods have decreased and low waters have markedly improved. A full inquiry into both classes of conditions, as will be shown, seems to prove that there is a close relationship between the surface conditions of a watershed and the flow of water through the stream which drains it.

The following table gives records regarding the flow of ten important rivers of the United States, on which careful records have been kept for periods ranging from sixteen to thirty-four years:

FLOOD AND LOW-WATER RECORDS FOR TEN IMPORTANT RIVERS

Name of stream and point of measurement.	Area of basin, sq. miles.	High-water stages taken in this table, feet.	Low-water stages taken in this table, feet.	First and second periods of record.	High-water Data.						Low-water Data.						Number of Stations.	Mean precipitation in inches.
					Number of floods.	Days of floods.	Average times per year of floods.	Average days per year of floods.	Times of last period compared with first. Per cent.	Days of last period compared with first. Per cent.	Number of low stages.	Days of low stages.	Average times per year of low stages.	Average days per year of low stages.	Times of last period compared with first. Per cent.	Days of last period compared with first. Per cent.		
CLASS I.—Floods have increased.																		
Potomac, at				1890–1898, 9 yrs.	19	33	2.11	3.55	*	*	54	1,351	6.00	150.0	*	*	3	36.1
Harpers Ferry, Va. ...	9,363	12	3	1899–1907, 9 "	26	57	2.77	6.33	36.8	72.7	76	1,693	8.44	188.0	40.7	25.3	3	38.7
Monongahela, at				1886–1896, 11 "	30	55	2.73	5.09	*	*	66	912	6.00	83.0	*	*	2	39.76
Lock 4, Pa.	5,430	20	7	1897–1907, 11 "	52	100	4.73	9.09	73.0	82.0	90	979	8.17	89.0	36.33	7.33	2	39.27
Ohio, at				1882–1894, 13 "	46	143	3.54	11.00	*	*	79	1,333	6.08	112.5	*	*	3	39.89
Wheeling, W. Va......	23,820	22	5	1895–1907, 13 "	59	188	4.54	14.40	28.25	31.5	110	1,609	8.46	123.7	39.00	20.75	3	38.82
Cumberland, at				1890–1898, 9 "	32	89	3.55	9.90	*	*	61	1,261	6.77	138.0	*	*	3	46.27
Burnside, Ky.	3,739	25	3	1899–1907, 9 "	43	102	4.77	11.33	34.4	14.6	65	1,576	7.17	175.0	6.50	27.00	3	41.42
Wateree, at				1892–1899, 8 "	46	147	5.75	18.37	*	*	115	1,164	14.37	145.5	†	†	2	44.58
Camden, S. C.	5,135	20	6	1900–1907, 8 "	70	187	7.75	23.50	35.0	22.0	64	508	8.00	63.5	44.30	56.40	2	45.94
Savannah, at				1890–1898, 9 "	47	116	5.22	12.77	*	*	70	566	7.70	63.0	†	†	3	48.12
Augusta, Ga.	7,300	20	6	1899–1907, 9 "	58	170	6.44	17.77	23.4	46.5	41	292	3.56	32.0	41.00	48.00	3	46.58
Tennessee, at				1874–1890, 17 "	32	173	1.88	10.18	*	†	71	902	4.17	53.0	†	*	3	52.10
Chattanooga, Tenn. ..	21,418	24	2	1891–1907, 17 "	33	137	1.94	8.06	3.13	20.8	55	982	3.24	57.7	22.53	8.86	3	45.01
Allegheny, at				1874–1890, 17 "	39	92	2.29	5.41	*	*	99	1,747	5.82	102.7	†	*	2	40.13
Freeport, Pa............	9,220	16	2	1891–1907, 17 "	53	131	3.12	7.70	35.9	42.4	91	1,136	5.35	66.8	8.10	35.00	2	33.87
CLASS II.—Floods have decreased.																		
Wabash, at				1890–1898, 9 yrs.	21	351	2.33	39.00	†	†	38	1,365	4.22	152.0	†	†	2	38.61
Mt. Carmel, Ill.	26,300	15	3	1899–1907, 9 "	19	279	2.11	31.00	9.5	20.5	44	1,160	4.93	129.0	15.75	15.00	2	36.09
Red, at				1892–1899, 8 "	19	87	2.37	10.87	†	†	49	826	6.12	103.25	†	†	4	31.80
Arthur City, Texas....	40,200	20	4	1900–1907, 8 "	16	60	2.00	7.50	16.0	30.0	8	208	1.00	26.00	83.60	74.80	4	29.86

* Increase. † Decrease.

The Tendency is Toward Increased Floods

If the period during which the records have been taken on each of these streams be divided into two equal parts, and a comparison be made of flood conditions for those parts, we find that eight of the ten rivers show greater floods in the last half than in the first half.

On the Potomac River, for which measurements are given for 18 years, the number of floods during the first half of the period was 19; during the second half, 26. The number of days of flood during the first half was 33; during the second half, 57.

On the Monongahela River, measurements are given for 22 years. During the first half of the period there were 30 floods; during the second half, 52. The number of days of flood during the first half of the period was 55; during the second half, 100.

On the Ohio River, measurements are given for 26 years. During the first half of the period there were 46 floods; during the second half, 59. The number of days of flood during the first half was 143; during the second half, 188.

On the Cumberland River, measurements are given for 18 years. During the first half of the period there were 32 floods; during the second half, 43. The number of days of flood during the first half was 89; during the second half, 102.

On the Wateree River, measurements have gone on for 18 years. During the first half of the period the number of floods was 46; during the second half, 70. The number of days of flood during the first half of the period was 147; during the last half, 187.

On the Savannah River, measurements have continued for 18 years. During the first half of the period the number of floods was 47; during the second half, 58. The number of days of flood during the first period was 116; during the second half, 170.

On the Allegheny River, measurements are given for 34 years. During the first half of the period there were 39 floods; during the second half, 53. The number of days of flood during the first half was 92; during the second half, 131.

On the Tennessee River, measurements have been taken for 34 years. During the first half of the period there were 32 floods; during the second half, 33. The number of days of flood during the first half was 173; during the second half—in this case there was a falling off—137.

Mr. M. O. Leighton, Chief Hydrographer of the U. S. Geological Survey, has during the past year made an elaborate study of the floods of the Tennessee River.* In this study Mr. Leighton has isolated as far as possible the days of rain storm of sufficient magnitude to produce floods, and on this basis has made a comparison of the floods of the two halves of the period. Although the number of days of flood was less during the last half of the period than during the first half, Mr. Leighton shows that the precipitation decreased in an even greater degree. The results of this close analysis show that the diminution of the precipitation has been more than sufficient to account for the diminution of the floods. The natural result is that in proportion to the rainfall floods have increased; the percentage of increase being 18.75 in the last half of the period as compared with the first half. This study is undoubtedly the most complete and authoritative that has ever been made of any American river, and it seems conclusive.

The low water stages of a river are never a safe criterion by which to judge its real condition. A stream may actually raise its bed by silting, and thus the low water stage may be increased while the actual condition is as bad or worse than at first. A study of the low water data of the above table shows that intensified low water conditions, as signified by the measurements, do not correspond in all cases with intensified flood conditions. Of the eight streams above referred to, four show apparently intensified and four apparently ameliorated low water conditions. But for the reasons just stated, these records can not be depended upon as having any real significance in showing the actual flow.

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* "Floods in the United States," by M. O. Leighton, Chief Hydrographer, U. S. Geological Survey. Paper prepared for National Conservation Commission.

The constant increase in the frequency and duration of floods in these streams appears not to be due to change in precipitation. In two cases there has been a slight increase in precipitation. These are on the Potomac watershed, where, as the table shows, there has been on the average 2.62 inches more rain in the second half than in the first half of the period. On the Wateree, there was an increase of 1.36. On all of the other watersheds there has been a decrease ranging from .49 of an inch on the Monongahela to 7.09 inches on the Tennessee. It is thus clear that while floods have greatly increased in these streams, the tendency has been toward decreased precipitation.

While the record is given for only eight streams which show increased floods, it must not be understood that these are the only streams which show this tendency; rather they are examples—particularly are they examples of streams having their source in the Appalachian Mountains, whose watersheds have undergone certain changes.

What Has Caused Increased Flood Conditions?

Since it is apparent from the records that flood conditions have greatly intensified in many streams during the past two or three decades, it is important to consider the possible causes. Several factors are known to have an important influence upon stream flow. Chief among these are climate, topography, geology, natural or artificial reservoirs, soil, and ground cover. Climate must be understood as embracing precipitation and evaporation, with whatever influences them, notably, wind, humidity, temperature, and altitude.

Precipitation.—It is of course apparent that precipitation must modify stream flow in a vital way, because no water can flow through the streams that does not first come down from the clouds. The amount of precipitation varies greatly from year to year. The amount for one year may be twice as great as for another in the same place, and at one point it may greatly exceed or fall short of that occurring a few miles away. While varying in a marked degree for short periods, precipitation becomes much more nearly constant when averaged for a long period.

If the precipitation had correspondingly increased over the Appalachian Mountain region, then it could be said that the greater and more frequent floods are due to that. But the figures which are given, although from too few stations to be conclusive, indicate that on only two of the eight watersheds mentioned in the table has there been any increase (and there by small amounts), while in the other six there has been a decrease. The real tendency of the precipitation over these basins would therefore be, unless the figures are entirely in error, to decrease flood conditions. Consequently, we must conclude that the increased flood conditions are in no degree due to precipitation.

Evaporation.—Evaporation is an important factor in a region's run-off. More than half of the precipitation in the United States is said to return to the air without reaching the rivers. Evaporation is affected by temperature, air pressure, wind, and humidity. The influence of temperature goes beyond its effect on evaporation. A frozen soil hinders the entrance of storm water and sheds it quickly into the streams. The worst floods in some rivers are due to that cause, and follow rains which would not produce high water if they fell on an unfrozen surface. A region's run-off is affected by its topography and geology. The steeper the slopes, other things being equal, more quickly will precipitation reach the rivers, and more of it will go there. The underlying rocks exercise a profound influence upon the water which reaches them after passing through the overlying cover. Fissured, faulted, and stratified formations store water and conduct it with more or less regularity to springs. The control of stream flow by that factor is most pronounced in low stages. Floods are due chiefly to surface run-off; low stages are regulated by the flow of springs. Natural and artificial lakes and reservoirs may profoundly affect the run-off from a watershed. They regulate the surface flow as rock formations control the underground discharge.

Evaporation, temperature, topography, geology, and reservoirs affect the flow of one stream where it is to be compared with the flow of another stream, but not where two periods are compared on the same stream, as in this discussion. Therefore, they can be set aside as unimportant.

Soil.—Though the topography and geology of a watershed change too slowly to be readily observed, there are other factors in which changes may be rapid, radical, and of great importance. One such factor is soil. The soil, when considered as a factor in controlling run-off, is a complicated and delicate apparatus. It works admirably when in good condition, but it is easily deranged, and is liable to severe and fundamental injury by which its action on storm water may be lessened or almost entirely destroyed. Mistreatment frequently produces results of a serious nature in the drainage of a watershed.

Ground Cover.—Scarcely separable from the soil is another factor of equal or greater importance in the disposition of water. This is the ground cover, or to speak of it more particularly, the condition of the surface of the ground; that is, whether the surface is barren rock or clay, pasture land, cultivated land, or forest.

It is generally agreed by those who have studied the subject most thoroughly, that the forest offers the best conditions for absorption and underground storage. Next to the forest and on level ground possibly quite equal to it, comes well-cultivated farm land; then meadow and pasture land; while the worst conditions of all are to be found on barren surfaces of stone, clay, or gravel, which, because of infertility, are unable to support growth of any kind.

The reasons why the forest offers the best conditions for absorption and ground storage are several. It does so, in the first place, because the foliage of the trees forms a storage place from which water drips slowly to the ground for a considerable length of time after each rain; because the complex layer of brush, leaves, weeds, mosses, and vines, all in a more or less advanced stage of decay, becomes filled with moisture with each heavy rain, and holds it for a considerable time; because, also, the surplus water so stored continues to be absorbed by the upper humus-filled layers of earth; because, further, the temperature is lower and the air more humid in the forest than in the open; finally, because the snow lies there much longer. To these reasons must be added the mechanical power of the roots to go deep into the soil and break up the rocks, thus forming channels for the ready entrance of water into the earth.

The Principal Causes of Increased Floods

Since other known factors can not have accounted for it, and since removal of the forest in theory should produce this result, it appears reasonable that the clearing away of the forest on the mountainous watersheds of the streams which have been described has caused the great increase in frequency and duration of floods.

It is a known fact that the forests on these several watersheds have been cut away with great rapidity during the past thirty years. European conditions probably offer no parallel to the rate at which these watersheds have been cleared to make way for the rapid advance of agriculture, and to supply the great manufacturing industries with the wood which they require. Forest lands, which offer the best possible conditions for soil absorption and underground storage, have been changed to poorly tilled agricultural lands, which are not so good. Then these agricultural lands, after a few years, have been exhausted and their soil eroded into deep gullies. Finally, many of them have been turned into pasture, or even entirely abandoned, because they reached a condition where they could not support even a growth of grass and weeds. The best condition has been changed to the very worst condition.

Again, repeated burning of forest lands has tended to reduce the thickness and value of the ground cover, and to lessen the power of the soil to absorb and to store water, The extent of damage from fire, so far as water storage is concerned, is generally vastly underestimated. A forest fire strikes above and below the surface. It injures or kills the trees, destroys the undergrowth and brush, and consumes the great forest sponge, the ground cover, and the humus. The extent of the injury is, of course, not always the same. It is sometimes slight; sometimes very great. Repeated fires tend to every kind of injury that can possibly be inflicted upon a forest soil, completely destroying the cover down to the mineral substances, and thus rendering it defenceless against the attacks of erosion. When that stage is reached, it may be depended upon that the run-off of the watershed has been profoundly affected and the regimen of the stream materially changed. The fact that forest fires have repeatedly swept over the watersheds of the streams under consideration makes it easy to believe that this factor, combined with the clearing away of the forest for agricultural purposes, has been the chief cause of the intensified flood conditions which the records now disclose.

A Watershed Where Conditions Have Grown Worse

The Cumberland River is a good example of how conditions have changed for the worse on some of these watersheds.

The drainage area of the Cumberland River, above Burnside, Ky., comprises 3,739 square miles, and lies in the heart of the Cumberland Mountains.

The removal of the forest on this watershed is progressing from three causes: (1) Clearing for agriculture; (2) Lumber operations;, (3) Fires.

In 1890, when these measurements were begun, 21 per cent. of the watershed above Burnside was cleared; in 1908, the cleared area had grown to 32 per cent. During the eight years from 1900 to 1908, clearing of forest for agricultural purposes progressed on this watershed at the average rate of five-eighths of one per cent. per year.

The total stand of timber on this part of the Cumberland watershed is 6,212,531 M board feet. It is being cut away by lumbering alone at the rate of 4 per cent. a year. These figures show that timber is disappearing on account of lumber operations eight times as fast as it is removed to clear land for farming purposes. In other words, supposing that lumbermen cut clear as they go, eight acres would be stripped for timber to one cleared for agriculture.

At intervals of from one to five or six years, fires run through the woods on the hills and mountains where the Cumberland River has its source. The fires are more frequent and destructive in districts where part of the timber has been cut and the refuse left on the ground. The dry ridges burn oftener than the coves, because the latter are sometimes too damp for burning. In times of prolonged drought, however, fires run through the ravines and coves where the densest growth is found.

Though the fires are slow and small, they burn the leaf cover and the upper layers of humus at each visitation. This removes or injures the porous surface, one of whose essential functions is to arrest the storm water falling upon the slopes and afford it an opportunity to sink into the ground. With the packing of the surface, after the litter and humus have been burned away, the water flows down the slopes and quickly reaches the streams, where, if in sufficient quantity, it produces flood conditions. Low water follows, because the hard ground is able to take in but little of the storm water to be paid out slowly afterward.*

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*A more definite statement regarding the damage to humus by fire may be made for the upper watershed of the Potomac River. In Water Supply Paper No. 192, of the U. S. Geological Survey, it is shown that 838 square miles of the forest of this watershed had been so severely burned by repeated fires as to completely or almost completely destroy the humus. Other tracts aggregating twice that area had their soil severely burned, but not to the point of complete destruction of the humus. Considered together, these

The behavior of the Cumberland River shows a direct and positive relation between the run-off and the changed condition of the surface. The changes due to agriculture and lumbering can be definitely stated, but the extent and effect of forest fires are not subject to exact calculation. Yet, undoubtedly, all of these influences are active in producing the results as shown in the flood and low water records at Burnside. It is impossible that these results should be due to rainfall, because the rainfall appears to be approximately 10 per cent. less in the second half of the period. Since no other influences could have produced the result, there is no conclusion possible other than that the progressive floods and low waters have been due to the changes accomplished on the surface of the watershed.

A Watershed Where Conditions Have Grown Better

The fact that man by his operations may decidedly change the regimen of a river is shown not alone by those streams whose flow has been influenced by clearing away the forest, but also by streams whose watersheds of prairie soil, com-

burned-over lands have an area of over 2,500 square miles, or 27 per cent. of the drainage basin above the point of measurement. Assuming that the humus of the uninjured soil of the Potomac Basin would hold back for absorption two inches of water, and assuming that with the humus damaged, as in this case, the capacity of the soil for receiving water is lessened one-half, then one inch will be held, instead of two inches as formerly. In an area of 2,500 square miles, the inch of water, which was formerly absorbed, but now flows away quickly, amounts to about six billion cubic feet. During a heavy rain, that quantity of water in excess of what would flow off quickly before would go at once to the streams.

The rating table for the Potomac at Point of Rocks, where the measurements were made, shows that when the river is at a ten-foot stage, 61,000 cubic feet of water pass per second. The six billion cubic feet of extra flood water from the burnt forest is therefore sufficient without a gallon from other parts of the basin to maintain a ten-foot stage at Point of Rocks for thirty hours. The effect on succeeding low water stages is a logical one. There is simply six billion cubic feet less of stored water to come gradually after the rains cease.

pacted for ages by the trampling of buffaloes and more recently by cattle of the great ranches of the West, have been to a large extent brought under cultivation.

A stream which shows this tendency in an unmistakable way is the Red River, which forms the boundary for many miles between Texas and Oklahoma. On this stream records of flow are available for sixteen years. A falling-off in the rainfall occurred on this watershed, there being 1.94 inch less water per year in the second period than in the first. Its drainage basin is, and has been during the time of its known history, practically without forests, only one acre in ten being forested.

Why has the Red River constantly changed its flow toward steadiness and uniformity, while many other rivers have changed in exactly the opposite direction? The area of the Red River drainage basin above Arthur City, Texas, where the records were made, is 40,200 square miles, divided almost equally between Oklahoma and Texas. In this river, as in those before mentioned, the geology and topography have not changed. The precipitation has changed considerably in the direction of lessened rainfall, but not enough to account for the record. In soil conditions, however, and especially in the condition of the surface, the change has been marked. At the beginning of the period of measurement, in 1890, the country was for the most part occupied by large ranches; the native prairie sod had never been broken up.

On the part of the watershed lying in Texas, there had been some settlement at an early date, but as late as 1900, no more than 12 per cent. of the Texas part of the watershed had been improved. In the Oklahoma part of the basin, in the same year, the improved portion was 16 per cent. Development began most extensively about 1900. In southwestern Oklahoma, in that portion drained by the Red River, it was stimulated by the opening of Indian reservations to settlement. The Cheyenne, the Arapahoe, and the Wichita lands were opened, it is true, in 1890, but the real opening of the country to settlers came in 1901, when the Comanche, the Apache, and other Indian lands were opened, aggregating over 10,000 square miles or more than one-fourth of the entire Red River Basin above Arthur City. Another tract of over 8,000 square miles, the Choctaw and Chickasaw lands, began its development about the same time. A summary of the figures shows that in 1908 the Red River Basin, in Oklahoma, had 10,200 square miles of improved land, compared with 3,284 square miles in 1900. Statistics are not complete for the Texas portion of this basin, but the Texas portion has developed at about the same rate as the Oklahoma part. It is probable that the whole Red River Basin, above Arthur City, in Texas and Oklahoma, had 40 per cent. of its land under improvement in 1908, compared with 14 per cent. eight years earlier.

The results which have appeared in the form of change of the flow in the Red River are precisely what ought to be expected from the changes in surface conditions. Theoretically, such results should appear, and as a matter of fact they have appeared. The hardened prairie soil has been broken up and changed into cultivated fields upon 40 per cent. of the area, and thereby the absorptive capacity of the soil has been much increased. Upon the remainder, prairie fires have been kept out and a better growth of grass secured. The extension of cultivation and the improvement of the grassland has tended to equalize the flow of this river. The river's behavior has become better as the area of wild land has decreased. In other words, the change of a large part of the watershed from the worst condition for the protection of a watershed to next to the best condition has brought about this result.

To sum up, on the Cumberland, as the watershed changes from the forest, the best condition for stream protection, to farm land, to pasture land, and even to barren condition, the very worst condition for absorption, the flow of the river is made more extreme, both as to floods and low waters. On the Red watershed, beginning with a wild, almost barren compacted surface, cultivation has changed the condition to that of permeable farm lands, which, next to forests, offer the best conditions. These two streams exemplify, therefore, in different directions, the working of the same law, that there is a vital relation between the condition of the surface of the watershed and the manner of flow of the stream which drains it.

Evaporation and Precipitation in Certain Appalachian Watersheds

Records show flood increase in the Potomac, Monongahela, Ohio, Allegheny, Wateree, Savannah, Cumberland, Wabash, and Muskingum. Five of these rivers have rating tables by which their discharge can be calculated, and in all of the five the amount of water discharged has increased in recent years, notwithstanding a general tendency to a decrease of precipitation.

The increased discharge is not a relative quantity based on a smaller rainfall, but is actual, whether precipitation has increased or not.

Two apparently contradictory results appear, *viz.*, smaller precipitation and larger run-off. If the run-off took care of all the water that falls from the clouds, a diminished rainfall would always produce diminished stream discharge. But such is not the case. Evaporation comes in as a very important factor, and it must be considered in connection with the run-off from a watershed. Taking the whole United States together, more of the precipitation goes back to the air as vapor than goes to the sea through the rivers.

After meteoric water has come in contact with the ground or ground cover, it is disposed of in four ways. A small portion flows by underground channels to the sea. Another small quantity, which probably does not amount to an inch of rainfall in forty years, enters into chemical and other combinations with plants and remains fixed until the decay or other destruction of the plant fibers gives it back to the air. The rivers carry another part to the sea. The residue is evaporated. For the ten rivers under discussion, the underground flow to the sea and water absorbed in plant growth are so small that no further consideration of them is necessary. What the rivers carry and what evaporates are the important factors.

For a given amount of rainfall, an increase in stream flow means less evaporation; and it follows that greater evaporation means smaller run-off. The gain of one is the other's loss. When precipitation and stream discharge are known, a region's evaporation may be calculated. Such calculation has been made for the Potomac, Ohio, Savannah, Wateree, and partly for the Muskingum. Precipitation, according to the records, shows a small increase for two of these watersheds, and a decline for three; but in all of them a considerable decrease of evaporation has occurred corresponding inversely to an increase in run-off. A summary follows:

Potomac, for a 12-year period. The precipitation was 4.42 inches more in the second half of the period than the first, and the evaporation 1.31 inches less.

Ohio, 24-year period. Precipitation for last half was 7.56 inches less than for the first, and evaporation was 31.4 inches less.

Savannah, 18-year period. Precipitation was 13.86 inches less in last half; evaporation 44.12 inches less.

Wateree, 16-year period. Precipitation was 10.88 inches more, and evaporation 57.91 inches less,

Muskingum—the years 1890-93 compared with the years 1904-07. Precipitation was 18.75 inches less for the last period, and evaporation 50.79 inches less.

Records for eastern United States south of New York show a tendency to a decrease in precipitation, an increase in flood conditions, an increase in stream discharge, and a consequent decrease in evaporation. Changed surface conditions have probably caused the increased run-off.

This question presents itself. Is there any ground for suspecting that the more rapid shedding of meteoric water from the changed surface has decreased the region's evaporation? If so, has the decline in evaporation caused any part of the decline in rainfall?

Evaporation within a drainage basin can act only on that portion of the rainfall which does not flow away and escape. The baring or partial baring of a soil would, in most cases, increase the evaporation, rather than lessen it, and would therefore decrease the run-off, provided the water would remain on the bared soil long enough to be evaporated. That is exactly what does not happen, for the water flows away before it has time to dry up.

In these facts lies the relationship, on the one hand, between the injury to the surface and an augmented run-off, and, on the other, between larger run-off and smaller evaporation. Is it not probable that ratios go still further, and that relationship exists between evaporation and precipitation in a region no more extensive than the watershed of a river?

Water must go up as vapor before it can come down as rain. A lessening of evaporation anywhere in the world must diminish precipitation by that amount somewhere. It is true that the place where rain falls and the place where the vapor rises are often far apart. But are they always far apart? A jet of stream thrown into the air from a pipe condenses and falls a few yards away. A column of vapor rising from a mountain-side may do likewise.

What effect on precipitation in the eastern part of the United States might be expected to follow decreased evaporation? A smaller evaporation from a region of some hundreds of thousands of square miles ought to have some appreciable influence on the moisture in the air over the region. The rising vapor adds to what the atmosphere already holds. When less rises, the total carried by the wind must be smaller; and since precipitation is nothing more nor less than the falling back to earth of that portion of the moisture which the overloaded air can no longer carry, it follows that if winds entering a region are saturated, or nearly so, their contact with vapor rising from the earth may quickly overload them. In that case, some of the load will be thrown down. It may, for all we know, fall very near the place where it went up.

On the contrary, if little vapor rises to meet saturated winds, they may be able to carry their loads across the region and out of it. In any specific case it is difficult or impossible to determine how much more load the winds can carry, or when a point of saturation will be reached at which they must unload.

When an attempt is made to show what does become—not what may or might become—of the moisture which the air over the eastern United States receives from the region's evaporation, the problem is difficult or impossible. Nothing better than probability can be claimed. Whether vapor rising from one side of a mountain will fall on the other side as rain, or whether exhalations from one valley increase rainfall in another nearby, are hard matters to prove or disprove. Rain is seen falling, but no man can possibly know whether it rose as mist from field or forest a few miles off, or whether it comes down from mighty air currents which carried it half-way round the world.

Many facts, or supposed facts, have been cited by investigators to strengthen the claim that in certain cases local conditions influence local rains. Reference was recently made at the Milan Congress to both Egypt and St. Helena, where it is alleged that marked increase in precipitation has followed tree planting on a large scale. There is no question that if a law exists, it works both ways. If afforestation augments rainfall, deforestation will lessen it. In the part played by such a law, and in explaining or accounting for increase or decrease in precipitation, the effect of regional evaporation is worthy of close study and careful consideration.

Most of the rain on land comes from the ocean, and much of it travels long distances; but some of the rain must come from land vapors. Evaporation in the eastern part of the United States is half as much as rises from an equal area of the Atlantic Ocean off the coast; and for the whole United States it is equivalent to a yearly rainfall of sixteen inches. Who can doubt that such an enormous quantity of water rising from the land and joining the moisture-laden winds from the sea, profoundly affects the country's rainfall by increasing it over wide regions? It is unthinkable that all this vapor is carried beyond our shores before it falls. It must add to the country's rainfall somewhere, and why not near the place of its ascent as well as far off? Reduce the quantity of moisture rising from an extensive region, and it is reasonable to expect a response in the form of diminished precipitation.

During the last four years of the Muskingum's record, the evaporation from its watershed was apparently twelve inches a year less than for the first four years—there being an intervening period of eleven years. The lessened quantity of moisture must have affected the winds which crossed the region, and their response was a decrease averaging four and one-half inches a year in precipitation as compared with the first four years of the record.

It does not affect the question of land evaporation's influence on rainfall whether our rain winds come from the Atlantic or the Pacific. The point is, does an addition of moisture rising from the land compel the passing winds to part with some of their vapor load, and, conversely, does a deficiency of vapor from the ground make it possible for winds to pass on without unloading?

A decrease in evaporation from the ground in the Appalachian region has apparently occurred. If it has occurred, the load of the winds has been lessened by that amount, and a decline in precipitation ought to have followed. Apparently, such decline has occurred.

SHAKES AND SHAKE-MAKING IN A CALIFORNIA FOREST

CHARLES HOWARD SHINN

Contributed

It is possible that this brief presentation of the claims (and the limitations) of one of the almost unknown and minor industries of the California pineries may seem to you merely a special plea on behalf of a few mountaineers who are trying to maintain themselves single-handed with obsolete weapons against modern conditions. But if I am only able to present this topic clearly, in all its bearings upon forestry, you will discover, I hope, that it seems to define and help us toward the solution of some of those larger problems which every forester must wrestle with and must conquer or we cannot build up our profession.

Nowhere, as yet, is there any really accessible literature of shakes and shake-making. It has not been printed, and has hardly reached the files of Forest offices. We have, it is true, an enormous amount of official correspondence on this subject, much of which, I think, originated in the Sierra Forest, where the shake industry has been studied and experimented with for the last six years. While shakes are being made all over California, the industry here has long been one of considerable local importance, which could not be destroyed without reason, nor really modified to meet the demands of scientific forestry without painstaking and unprejudiced investigation.

We are even almost without any general and picturesque literature respecting shakes and shake-makers. Bret Harte wrote a story about them which bore scanty relation to the facts; John Muir pitches into those slashing, old time shake-makers of the Sierras (whom no one can defend) with his almost irresistible eloquence of invective. I have looked in vain through the ten volumes of "Garden and Forest," and through perhaps fifty volumes of California publications, for more than casual allusions to the subject. The second biennial report of the old California Board of Forestry (1887-88) contains this paragraph in a description of *Pinus lambertiana:*

> The Great Sugar Pine excels in evenness and straightness of grain, hence making excellent timber for riving into shakes or shingles, and this quality has led already to the shameful destruction of thousands of noble trees on Government land. Lawless vagabonds penetrate the Sierra forests, with only the equipment of an ax and a long saw, and leveling these monstrous trees they saw out a cut, examine it, and, perchance, move on to the destruction of others, leaving to rot on the ground trees that would yield to the careful lumberman 20,000 to 50,000 feet of clear lumber worth hundreds of dollars.

This is extremely characteristic, and in fact very fairly sums up the almost universal view respecting those old shake-makers, whose products thousands of people bought, whose methods no one then tried to improve, and who, though quite as interesting and as worthy of study, in my humble opinion, as the rivers of North German split-staves, or the charcoal-burners of the New Forest, only began to be considered as having immortal souls worth saving, so to speak, after the National Forests came into existence.

At times, as we know, all things turn on a definition. None of the dictionaries, none of the encyclopedias, seem able to tell us exactly what is meant by that hand-made article which is sold by the million in some local California markets as a "shake." In fact, there is endless confusion in regard to "shingles," "clapboards," and "shakes." Nor do I find the distinction noted, nor a "shake" defined, in any Forest Service publication. The Standard Dictionary comes as near to it as anything when it gives the following as a minor meaning to the noun "shake": "A rough, unshaved shingle, used to cover barns and shanties." Only by implication can "rough, unshaved" mean "split." Worse, a reference to the Standard's definition of "shingle" shows that the whole essence and meaning of "shake" has been missed.

Evidently, then, we must break new ground in our study of this curious survival of a prehistoric past—of split lumber used *exactly as it comes from the riving-knife,* without shaving thin at one end (to make a "shingle") or thin on one side (to make a "clap-board"). A "shake" is not a "shingle," nor even a "split shingle," nor yet a "clap-board," sawn or split. It is still made as it was made thousands of years ago; it antedates everything sawed. It was once of all possible sizes and thicknesses and had a thousand forgotten names. Briefly, it was the primitive building material, next after stones and clay, poles and bark, and before the teeth of the saw were cut.

And all this primeval forgotten industry survives for us in the sugar pine shake of the California Sierras. I have gone out with the shake-makers, whose technical vocabulary contains old Anglo-Saxon root-words, and as I have seen them cleave a tree into bolts, and rift the bolts into thin, flexible, fragrant "shakes," fit in softness, color, and beauty for the roofing of a palace, I have been more than willing to believe that just such products as these of axe and "froe" (the saw being still merely a convenient adjunct of the business) were made of old by the sons of Usnach for the dwelling of Deidre, and were riven for the roof of the Volsungs in the days when Odin walked among men.

Such was the glory of its past in literature—this group of split-wood industries of which only a few branches survive. Men made floors, timbers, roofs, settles, tables, and all sorts of things with axe, wedge, and "froe." One comes upon it everywhere in classic and mediæval art and literature, and well down into American colonial times; then it moved west with the pioneers. Little by little the peculiar tool of the work, the "froe," was developed into varied shapes and sizes. (Webster's Unabridged ignorantly defines it as "an iron wedge.")

Some of the ancestors of the modern California "froe" are illustrated in the fifth volume of Schlich's Manual, where split barrel-staves are described, and the two instruments which Dr. Gayer calls "dividers" and "shave" are mentioned. I turn to Mr. John Murdoch's report of 1907 on shake-making in the Sierra Forest. (Mr. Murdoch was Forest Assistant in charge of some sales.) "The froe," he says, "is a plain steel blade nine or ten inches long by an inch and a half wide, and about a quarter of an inch thick on the back. At the heel of the blade is an eye so set that the handle stands up at right angles in the plane of the blade." He might have added that the so-called "froe" sold in hardware stores is considered useless for first-class work, but that a country blacksmith's product, costing five or six dollars, is eagerly sought for.

Dr. Gayer alludes to the split-wood value of ash, chestnut, oak, and other woods (not to any conifer). Baron Ferdinand Von Müller and Professor J. H. Maiden in their famous studies of Australian timbers are continuously noting "wood easily 'fissile,'" "split into shingles, posts, staves, clap-boards." In India the deodar cedar is so used; in our own colonial times oak, chestnut, and cedar.

The "shingles" on the roof of an ancestral homestead in Farmington, Connecticut, built in 1700, were "rived" out of oak, not really dressed at all, except being thinned with an axe. They were perhaps eight inches wide, twenty inches long, and nearly as thick at one end as at the other—almost "shakes" in fact. They remained more than a century in place and were weathered down almost as thin as paper.

In Maryland, in 1883, I bolted, rived, and then shaved some chestnut shingles on an old Harford County farm. The owner of the farm said to me:

> "My grandfather made clap-boards and shingles, and built a cabin entirely out of split stuff."
>
> "And how did he split it—with what tools?"
>
> "I think he used an axe, and wedges—no, nothing like a 'froe' as you describe it."

We are apt to forget the importance of split materials in every pioneer community. I spent the summer of 1875 in the Santa Lucia Mountains of San Luis Obispo, a hundred miles from a railroad. One of my friends there, old Uncle Nate, took his axe, wedges, saw, and "froe," and attacked the white oaks (*Quercus lobata,* growing along the gulches). He first split out his floor-joists, studding, rafters, sheeting, and tie-pieces (the ground-sills were hewn). Then he split "shakes" for the roof and the sides. Each shake was 36 inches long, and 6 inches wide, and ⅓-inch thick. They were put on the sides in "clapboard fashion," and on the roof "shake fashion." He split "puncheons" five feet long for the floor, and dressed them a little with the axe. He made chairs, tables, settees, cupboards, and everything else that he needed. He built the chimney corn-cob style, out of split sticks and clay. Then he split posts and rails to fence in his "claim." His fathers' fathers had done in like wise, all the way back to their primeval homes in some great Asian wilderness.

If even this were all there is to the rived timber product, which in its highest modern form we name a "shake," I should not write this article. But the American pioneer came to Oregon, Washington, and California, and found some of the most rivable and beautiful timber on earth. So he not only made his houses more or less with axe and "froe," but after he began to plant vineyards he discovered that the split shake exactly filled the bill for a "drying tray." Therefore the whole shake-making industry took a new start in many localities, obtained a firmer commercial foothold, so to speak, and now wants to continue as long as it can buy available timber, and can compete with the men who make a "sawed shake" (which last is by no manner of means a "shingle," being uniform in thickness).

To go back just a little in this historical sketch, a Californian pioneer from Maine is said to have first split out sugar pine shakes in 1848, near Georgetown, El Dorado County; from them he made a cabin, putting on the shakes clap-board fashion from the ground to the ridgepole. After a few efforts of this sort the regular modern, or standard, roof-shake came into use—32 inches long, 5 or 6 inches wide, and ¼-inch thick, and as uniform as the skill of the shake-maker and the quality of the wood permitted. In a few years several thousand men were rambling about the forests of the Sierra Nevada Mountains "making shakes," and having a mighty free and easy time of it.

But their product was for a time sorely needed. These were pioneer days, I am told, before a single redwood shingle had been cut, when Oregon shingles cost $20 per thousand in San Francisco, $25 in Sacramento and $45 in the Sierra mines. The price of the outside product thus created and maintained the shake industry everywhere in the mountains. I explained the details of all this in an article entitled "Among the Shake-Makers," published in *Forestry and Irrigation* (now *Conservation*) in July, 1907. Those who care to know more about the picturesque side of the subject will find it there.

Let us now take up the particular. When I came to the Sierra Forest, in 1902, I found a number of shake-makers at work on private lands. The most cursory examination of the sugar pine belt showed plainly that many trees had been cut by shake-makers, and that a large proportion of these had been felled, found unworkable, and left on the ground. The older shake men explained this to me as follows:

> In the early days of shake-making, all over California, each man cut a tree wherever he pleased, and then tried it, to see if it would rive. Little by little men got notions about the bark, and the way a good shake tree "looked," though no two men ever agreed about these points. The number of wasted trees lessened. Then somebody—we don't know who—began to take test chips out of each promising tree, and so we found that we could very nearly stop the waste.

This is really just the way it happened. Here in the Sierra Forest, as late as 1891, no one ever took a trial chip from a tree. At the present time one who fails to do so, or who does not understand how to test the chip, cannot keep in the business a single season, under Forest regulations. We have practically eliminated gross waste.

An Inspector once asked me why a shake-maker should not be compelled to use an accretion-borer and then examine the core instead of taking a chip out of the tree trunk—or sometimes several of them. The reason is plain to one who has the observing eye. The man has to make a miniature shake, several of them at different angles, to decide whether on a large scale he can handle the tree. He often reaches such conclusions on little strips of wood, two inches wide and four inches long. To me this item is an undying marvel of the woodsman's instinct and training. The compressed little column of the accretion borer is altogether useless.

Pause here, and note how great is the problem from the woodsman's point of view and how superbly he has solved it. As I have said, *Pinus lambertiana* is the shake tree of America; in our best forests it yields a really good riving tree out of every seven, eight, ten or twelve, according to moisture, soil, and other conditions. By "good" I mean what shake men call "a real nateral rivin' tree." The fact that the problem is solved, and that a tree that will not rive is very seldom cut, shows what the Forest Service has already done out here toward making safe and legitimate a once outlawed industry. The best shake-makers of to-day begin to acknowledge that it no longer pays to buy from the Government any except these natural shake trees.

Given the natural shake tree, and what happens is this: One man comes up against it with one helper, cuts it down, saws it into shake lengths, bolts it out, splits his shakes, snakes them out through the rocks and brush to a wagon road somewhere, and more than makes wages, with no capital to work with. One tree cut in 1904 in this Forest, by two men, yielded 60,000 shakes out of 15,000 feet (board measure) that was actually worked, and 5,000 feet paid for but left unused on the ground (afterwards used for firewood). The stumpage price for sugar pine at that time was only $1.75 per thousand feet (log scale). The shakes sold on the ground for $420. Deducting what was paid the helper, a good shake-maker on such a tree as this, which the two could handle in twenty days, would easily clear $325 above the cost of living. The particular tree from which I took these facts was three hundred and eighty years old, broken topped and decadent. Seed trees were all about it. No sale to a mill was in sight for years. I hold that this sale to shake men was then necessary. The ordinary stumpage for sugar pine, here, in 1904, on private lands, was from 50 cents to $1.00.

It used to be held by the mountaineers that the shake men always worked their timber better than the mill men did, obtaining a greater value from it. Such a case as the one above cited seems to support this view, but further observation showed the Forest officers that the commonly received view was decidedly wrong. The practice of the shake-makers was susceptible to very considerable improvement; but even then, taking his trees as a whole, it appears that the mill man's product is worth more in the end.

Nevertheless, the woodsman feels that he has solved the problem to his own satisfaction. As he tells us, he can make a good living out of the Forest, in the face of the small mill and the large mill, "if the Government will only give me a fair show" (as he is apt to put it).

Summed up, the modern shake-maker of the Sierra says about this:

> I see that soon I shall manufacture principally grape-tray shakes, 24 inches long. The 32-inch roofing or standard shake I used to make is now merely a side show. Every acre of vineyard in the San Joaquin Valley requires from 300 to 500 drying trays. A split sugar pine shake is the best thing to use, and lasts from twenty to thirty years, while sawed shakes or shakes of other timber are much less durable. The demand for grape trays requires the National Forests to sell me for my work all the natural shake trees in the whole sugar pine belt. This will be from 10 to 15 per cent. of the available milling timber, and will last us 30 years. We will pay as high stumpage as any mill man can pay. The mills will buy what is left, just the same.

Then we say to him, perhaps, something like this:

> It is not right to destroy our most valuable timber, until it is fully mature; that is against the principles of forestry. Use more fir; find some way to work up your tops; introduce shingle and tray mills; prepare now, while there is time, for the coming railroad, even if you still use a "froe" part of the time.

Further, the shake-maker points out with noteworthy emphasis that the fundamental requirement of his local split-wood industry is this: that he be permitted to pick out his own trees (subject at the most to seed-tree requirements). And meantime he goes right on paying $5.00 per thousand stumpage (log scale) for all milling timber, making his tray shakes and roof shakes in isolated localities, and out of "sugar-pine pockets" in the mountains so remote and scattered that no sawmill will venture there for years to come. Is this not a most interesting survival of prehistoric practice, and of days long before the circular saw?

Of course you understand that the real views of the shake-maker are even more aggressive than he usually expresses. He has all the pioneer's pride and all the skilled craftsman's joy in his work. He wants to be "put in the best timber"; he does not want to look forward to taking wages from some great mill company of the future. Lastly, he firmly believes that he leaves the Forest in better shape than the mill does. He is not able to say: "I am the man who can give you Forest fellows an *'improvement cutting, pure and simple'*—if you will give me a chance,"—but he thinks it. If we were working with a pure stand of sugar pine of different ages here, I think the shake-maker might truly be the man for us. Even as it is, I hold his point of view worth a thought.

Let us now study the more detailed history of shake-making in this Forest; then let us compare some of the results of the shake industry with the mills; lastly, let us discuss the true relations of both, especially as regards our sugar pine, to the principles of wise forest management.

The history of the shake business here began with (1) a petty case of trespass in 1903 which severely frightened a somewhat typical shake-maker, and, so to speak, converted him—not deeply, but enough to answer the purpose; (2) with a sale by the old land office of 150,000 feet (board measure) of fine sugar pine, to a shake-maker for about $2,000. In the last case the shake-maker worked up the material in two summers and appears to have supported himself and his family in the woods and to have cleared two or three thousand dollars above expenses. It was a nice, clean sale, in good timber, and the waste material left on the ground has since been used by campers for firewood.

Small shake sales were made in 1905 and 1906, some on a board measure basis, some on a basis of the number of shakes made. The latter was much preferred by the average shake-maker, but the objections were found by us to outweigh the advantages. It saved scaling the trees, but one wants to train rangers anyhow. Moreover, it did not make for close working.

Mr. W. E. LaFountain of the Service came out in the summer of 1907 and made a careful study of the shake camps on Shuteye Mountain so as to determine the relative cost of the sugar pine timber as used by the shake-makers to that paid by lumbermen for the same kind of timber. He chose six average trees, ranging from 3 feet 7 inches to 6 feet 4 inches in diameter on the stump (18 inches high). The total number of board feet (log scale) in the six trees was 41,864. This timber at the then ruling price would have brought $170.83 from the mill man. But the shake-maker, who produced from these trees 171,080 shakes, paid $213.85, or $43.02 more. The only bad feature of the transaction was that the shake-maker was forced to leave 14,980 feet of waste which the lumberman might have utilized. The small tray mills in operation in some parts of the Forest, producing a sawed grape-tray bottom, manage to use a large part of such top waste.

One of the first reports ever made on the industry here was that of John Murdoch, Jr., who was a Forest Assistant here in 1907 and spent two months in charge of a group of shake camps. He described in great detail the sawing and bolting, the riving, the check, the brake, the way pressure is applied by the craftsman, the baling and marketing, the tools used, and all the various items of the work. He estimated the expenses and the average profits. He gathered from old shake-makers the "signs of a shake tree," the "riftage," the "waves," the "welting" just under the bark, the straight resin canals, and above all the taking and the examination of the chips. He ended this report with a spicy local shake-camp vocabulary.

The experience of 1907 made it evident that we must urge the shake-makers to put in small shingle and tray mills as fast as practicable, and must also encourage them still further to improve their methods. The Service returned in 1908 to the system of selling by board measure, log scale, raising the price of sugar pine to five dollars a thousand. The shake men did not really pay much more, but they were made to recognize more plainly the advantages of close working. By this time we had gained the confidence of thirty or forty men who were buying shake timber, and we were learning to understand their point of view, as they were beginning to recognize ours.

One of the best reports of 1907 was made by Ranger John M. Miller. It throws much light upon the methods of riving and the local differences of workable timber. Mr. Miller compares a group of three shake-makers at Signal Peak with a group of three at Shuteye. He says:

> The shake timber in both places was situated at the same altitude and in the same general forest type. The sales were conducted at both places in about the same manner, by about the same number of men. Still, a comparison of these two camps shows differences in regard to the quality of the shake timber, the method of riving and the number of shakes produced per board foot. Some of the Signal Peak timber averaged as high a number of 32-inch shakes per board foot as the Shuteye timber did for 24-inch shakes.
>
> A difference of soil and exposure may account, to some extent, for the difference in the quality of the timber. The Shuteye trees were mostly located upon rough granite ridges with little soil, and on southern slope and exposure.
>
> The Signal Peak Ridge, although high and exposed as Shuteye, has much less of granite outcropping, and a far better depth of soil.

Many of the trees cut were on the northern exposure of this ridge. The Shuteye trees were, as a rule, short-bodied, with many large limbs, representing the poorer grade of sugar pine. The Signal Peak timber was long-bodied, with few limbs—the very best type of sugar pine to be found in this Forest.

A different method of riving and bolting was in use at both of these camps but it did not appear to make any essential difference in the quality of the shake produced. At Signal Peak the bolter marked off each section of the cut so that each bolt on the outer tier would make 64 shakes. All additional division of the bolt was done by the river with his froe. He did not check the bolt, but simply divided each piece by his eye. His brake consisted of one upright piece with a jaw at the foot.

At each of the Shuteye camps, the bolter divided each tier down to a series of 16-shake bolts. The river then "checked" these off with his froe before dividing them any further. The brake used consisted of both the jaw and a long trough in which to stand the bolts as he rives. This is sometimes known as the hog-trough brake.

Each river is thoroughly wedded to his own system and looks upon the method of the other with suspicion and contempt. The system of using the 64-shake bolt seems to be the older, and apparently was used by the first shake makers of the Sierra. Some mountaineers claim that the system of using small bolts and checking originated on the Pine Ridge, in the Markwood Meadows camps.

All six of these sales were made at a certain rate per thousand shakes, and the amount of timber left in the top was scaled and charged to the buyer. I also took the scale of each tree as it was felled, and kept a separate record of its shakes in order to work out the following table. The data were taken from a number of representative trees from each cutting. The name corresponding to the number represents the timber sale under which the purchase was made.

SIGNAL PEAK CUTTING

Tree No.	Diameter, inches.	Distance worked, feet.	Board feet.	Shakes 32 inch.	Shakes 24 inch.	Shakes per board foot.	Board feet in top.
Chapman, 1........	52	120	9,020	27,300	....	3.1	220
" 2........	48	102	5,590	21,500	....	3.8	490
" 3........	..	58	7,490	25,000	....	3.3	5,990
Loevenguth, 1......	46	83	4,290	15,250	....	3.7	150
" 2	66	90	9,830	39,640	....	4.	....
" 3......	58	107	8,120	34,540	....	4.2	530
Standart, 1.........	66	86	8,510	30,700	....	3.6	440
" 2.........	58	106	11,304	47,740	....	4.2	....
" 3.........	54	84	7,160	33,700	....	4.7	....

SHUTEYE CUTTING

Tree No.	Diameter, inches.	Distance worked, feet.	Board feet.	Shakes 32 inch.	Shakes 24 inch.	Shakes per board foot.	Board feet in top.
Geddes, 1..........	69	64	12,840	23,600	21,250	3.5	3,200
" 2..........	62	56	4,850	16,050	.....	3.2	.....
Noland, 1..........	54	70	4,800	.....	25,000	5.2	440
" 2..........	49	40	3,100	.....	13,760	4.1	2,600
" 3..........	63	84	6,240	.....	2,724	4.3	810
Merriman, 1........	58	48	4,810	.....	18,426	3.8	440
" 2........	57	106	7,850	.....	29,400	3.7	380

In 1908 the shake-making industry reached its highest point in Sierra Forest; it will probably never exceed the totals of last season. According to an exhaustive report on the history and development of the industry which was recently made to me by Mr. Tompkins, Mr. Noddin, and Mr. Howard of this Forest, we had in 1908 twenty-five different camps, some of them large, which worked up in all about 1,500,000 feet (board measure), into shakes for roofs and for grape trays. The shakes varied in size to suit market needs. The shake-makers varied greatly in their ability to work close. Something like 5,000,000 shakes, however, went out of these camps into the foothills and the San Joaquin Valley. They distinctly entered into competition and more than held their own with shingles and with the sawed tray shakes. These camps "made business good" in all the local stores, employed teamsters, and helped the community as a whole, it is thought, quite as much as a sawmill using four times the timber could have done.

But on this larger scale, the natural limitations of the industry, when standardized and reduced to a system, became more evident than in 1907. The best results were obtained from the smaller camps. The more ambitious shake men who hired several helpers and "ran three or four 'froes'" (*i. e.*, employed that many rivers), did not do as satisfactory work as those who rived for themselves and merely hired a helper or two to bolt, pile brush, etc. The ideal shake camp consists of not more than three persons. Hence arose the new rule that we have made here for 1909—"one 'froe' to a camp."

This new rule definitely puts an end forever in this Forest to the chances for any of those large shake camps which have often developed in California, where a man with a few thousand dollars in ready money buys timber, and subcontracts to the actual "froe"-wielders, who make the shakes while he finds wholesale buyers. I have seen fifty men in such camps and I seldom saw any nice close work done in the timber by a large crew. It used to be very easy for such speculators to secure the dangerous and indefinite right from private owners to "make all the shakes desired" on a given tract, often for a dollar or two per acre. Then trees would be felled for the sake of a few shake-lengths. The waste was enormous. Of course these larger camps, under Forest rules and paying high stumpage, are held down pretty closely, but this fact will in the end annihilate them. When sales are confined to "one 'froe' to a camp," only the expert river and timber-judge can make a good profit, and he becomes the actual purchaser. The total output of this Forest in 1909 will be 30 per cent., or more, lower than in 1908.

The best one of the large camps in Sierra made 648,100 shakes out of 205,210 feet of lumber from 31 trees. The material thus cost $1.60 per 1,000 shakes. As this was partly a holdover contract, the average price was less than $5 per thousand (board measure). At $5, the cost of the material per 1,000 shakes would have been nearly $2. But the best of the single-"froe" camps have brought this cost down to $1.40 and are likely to do even better in 1909. I think myself that the utmost attainable limit, with sales confined to the most expert men, with natural shake trees, and with one "froe" to a camp, is about $1.25 per thousand shakes for the stumpage.

We now turn to a closer comparison of the economics of the shake industry as compared with milling. The work of

1908 in this Forest was on a scale which enabled us to make many observations previously impossible. Never before in any part of California has there been such a chance to study in all its details the possibilities and limitations of an old handicraft such as shake-making. Never, until the Service took it up, were the shake-makers recognized as really legitimate users of forest resources and as worthy of all reasonable aid in finding their true place among the lesser forest workers.

The first business question then is this: Can the shake man get more final value (from the consumer's point of view) out of the sugar pines that he works than does the mill man?

When 1,500,000 feet (log scale) were worked up into 5,000,000 shakes, we reached our conclusions. I quote therefore the report alluded to from Mr. Tompkins and Mr. Howard, Forest Assistants, and Mr. Noddin, Timber Ranger. They took our statistics and worked out a typical shake tree as yielding 14,140 shakes and also as graded into lumber. Hence their following table:

Grade.	Thickness, inches.	Width, inches.	Price per M.	Amount bd. ft.	Total value.	
No. 1 Clear	1	14 to 20	$ 55.00	389	$ 21.39	
No. 1 Clear	1	22 to 30	110.00	352	38.72	
No. 1 Clear	1½	4 to 12	40.00	104	4.86	
No. 1 Clear	1½	14 to 20	60.00	256	15.36	
No. 1 Clear	1½	22 to 30	115.00	1,324	152.26	
No. 1 com.	1		27.50	416	11.44	
Total value of mill-man's product................						$243.33
Total value of shake-man's product (14140 shakes at $12 per M).............................						169.68
Balance in favor of mill man						$73.65

They discussed the above as follows:

In this table a sixteen-foot log 60 inches in diameter at the small end is considered. The scale accorded the mill man is conservative both in grades and amounts. An allowance is made for a quarter-inch saw kerf, which is the maximum that would exist. Then, too, the number of shakes allowed per thousand feet, B.M., is generous.

The prices for lumber, although obtained from the retail market in Fresno, California, are in some cases lower than the wholesale prices for the same grades given in the "Wholesale Lumber Prices for December," published by the Forest Service. The price for shakes is if anything higher than the average, and is taken from the same local market. Nevertheless the table shows that the mill man certainly gets the greater value out of the log. The amount of timber which is necessarily wasted in making shakes is another factor which must count against the shake maker in the end. This is not so great as might seem at the first glance, when one sees the large top-logs and the piles of unused hearts and waste shakes lying around in the woods. The smaller top-log and the slab, sawdust and planer shavings of the mill man will balance these in part.

The following table shows the relative efficiency:

EFFICIENCY PERCENTAGE

	Shake logs. Per cent.	All logs. Per cent.	Top logs. Per cent.
Shake-Maker	37	26	unused
Tray Mill	36	37	29
Circular saw board mill	65	63	50
Band saw board mill	72	67	55

The limitations of space of such a paper as this prevents me from giving in more detail the statistics upon which the foregoing is based. I trust that during the coming season all this shake material here can be put in shape for publication in pamphlet form, with illustrations.

But this count against the shake-maker, though serious, is not final, for until an equivalent can be offered for his first-class grape trays, the people demand the product. We are compelled to recognize the industry, at least for the present. We are in duty bound to search diligently for improvements and substitutes, better methods, cheaper timber. Above all, and at all times, the paramount question is the effect of the industry upon the future of the Forest.

One has no business to yield to any sentiment for these interesting mountaineers who wish to live by riving shakes. Neither should one scorn and put aside their industry as too small, or as using timber sure to be wanted later by mills. All that is really to be considered is the welfare of the Forest as a whole.

Let us examine the situation here. The area that Mr. Tompkins, my Forest Assistant, in his report of March 17, grades as "Sugar Pine Type" (mixed forest of *P. lambertiana, P. ponderosa, Abies concolor,* etc.) consists of, say, 182,900 acres. Of this 9,900 acres has been cut over. Only 1,308 acres of this last were cut under Government regulations. And the best 71,000 acres of the whole 182,900 acres were in the hands of private owners long before the Forest was established. The area of possible future sugar pine reproduction is thus sternly limited to about 112,000 acres, unless the Government can secure the 71,000 above noted as fast as it is cut over.

The last general timber estimate for this Forest (Feb. 17, 1909) shows that on 682,021 acres we have about 15,613,000,000 feet (board measure), of which 8.7 per cent. (or 1,361,300,000 feet) is sugar pine. The fir (red and white) is 48.2 per cent. of the forest, and the yellow pine is 25 per cent. Naturally everyone wants sugar pine and just as certainly *a sound forest policy will confine the sales of sugar pine to improvement thinnings.* It is the fir which must be sold, and much of the fir occupies territory where the sugar pine reproduces well if given a chance.

The whole situation makes it absolutely necessary to avoid large sales anywhere until the demand for fir increases heavily, with better transportation; it requires a policy of encouraging small local users, and of making many small sales as far as possible in timber other than sugar pine (except for strictly improvement cuttings).

But this does not necessarily involve indefinite sales to shake-makers. It is true that the "survival of the fittest" and the gradual, steady improvement of their methods, still going on, justify a reasonable continuance of small sales to the "men of the 'froe.'" But shake-making by hand is not really a permanent industry, here or elsewhere, under modern conditions; the most that intelligent forest management can do for it is to carry it forward on a gradually restricted scale until the transition period, now going on, merges into the era of small mills, adapted in every particular to the best needs of the Forest. To do less than this would be worse than foolish, for among the descendants of men of this very type will be found some of the most effective small mill-owners of the future.

I must define more closely the limitations of the shake man and his only possible future. In order to make shakes, a man requires less than $250 to buy Government timber, get his tools, hire his helper, and start his camp. Shakes are practically cash, or at least good for sufficient credit as soon as made. The shake-maker who will bank all of his profits can in five years become part owner of a shingle or tray mill. Both are adapted to his training and capacity. The best possible combination for small capital here is a tray mill for the main log and a shingle mill for close-working the shake man's waste. This combination will utilize fir as well as pine.

I tabulate as follows:

Industry.	Capital needed.	Men employed.	Timber used per year. Board feet.	Effect on Forest.
Shake-maker	$250	3	50,000	good
Shingle mill (separate)......	$1,500	4, and teams	75,000	"
Tray mill (separate).........	$1,500 to $2,000	7 or 8 & teams	150,000	"
Shingle and tray mill, combined	$2,500	10, and teams	250,000	better
Small portable saw mill, for local trade.............	$5,000 to $8,000	30 " "	1,000,000	good
Small saw, tray and shingle mill, combined.........	$10,000	40 " "	1,500,000	best

I think this table needs no discussion. It shows exactly what I believe should be the definite aim of our encouragement of shake-makers here. In fact this has been the local policy of this Forest since 1904, steadily kept before the shake-makers as the true goal of their ambitions.

But the large mill-owners, some timber inspectors, and many others bring up two arguments against even limited sales to shake men. First, the unused "tops" and "cores." The answer to this (in sugar pine) is that the durability of the timber is such that if in fifteen years shingle mills come in, they can work most of this up. Also, it is beginning to have a firewood value in many places.

Second, it has been claimed that the shake man's choice, *i. e.*, the "natural shake trees," are definitely and constantly the best trees of the whole stand. They mention Burbank, and ask if I wish to check the evolution of an even finer sugar pine. This question is crucial. In fact, it is largely for this one point that I have presented this paper.

Is there any reason to think, at present, that if the whole forest consisted of "natural shake trees" its value for lumber would be increased? So far as I know, there is not any such evidence. In the higher grades of pine, the soft, straight-grained wood often has an especial value, but so has the harder-fibered, more beautiful, unrivable product. All the large, healthy, accessible trees grade up high. No mill man was ever known to offer more for a higher percentage of shake trees.

Further, have we the scientific evidence that heredity, within the limits of a species, is the all-determining factor respecting fiber, softness of wood, and rifting quality? If we cut out the "natural shake trees" shall we have no more? Then certainly we should retain such trees as long as possible, for even if these qualities are not distinctly more profitable, they must not be lost to the Forest. We can run no risk of lowering the standard aimed at.

But all the observation of the men in this Forest goes to show that favorable soil, shelter from storms, certain conditions of climate and location, are the principal factors in so directing the growth of a seedling that it should develop into an ideal shake tree. The warm and wind-protected hollows, where the pioneers of fifty years ago went to pick out shake timber, seem still to show a higher percentage of good shake trees than do other parts of the Forest. This problem is open for further investigation, but as it now appears, the shake-maker, limited to a single "froe" to a camp, and placed on more remote and inaccessible areas, offers a somewhat unusual opportunity to watch the results of that conservative lumbering which the text-books call the "single-tree method." None of the mills now in existence here could survive if they took only one or two trees from a group, and twelve or fifteen from forty acres. But the shake-maker can.

Sufficient has been said to show that the picked shake-maker is learning to reduce his waste to the minimum. His way of growth toward certain forms of local mills has been indicated. But we find a certain conflict just here. The old shake man is apt to look on a tray mill (even his own) as only meant to work up waste; he thinks that he can still rive some. The trained tray-mill owner knows this is an error; it will be cheaper and better to saw the entire tree, and to saw many which the shake-maker cannot use and so to utilize all the timber that the forester wishes to sell on a given forty before moving to another. Eventually this last view will prevail, and the old mountaineer will hang up his "froe."

Lastly, the use of the cheaper materials will increase, especially for the grape trays, and veneer mills will find their special opportunity in this industry, working on the white fir, I think, more than on the pine. Cheaper transportation will enable the sugar pine shingle to drive the roofing shake out of market. The day of small mills, logging without donkeys, and making improvement cuttings, will have come to stay.

Then the foresters of Sierra will be able to approach the solution of our greatest single problem: How can we increase the growth of sugar pine on the areas where it really belongs? We ought not to aim at a pure sugar pine stand, but we can have large groups of nearly pure and still larger tracts where the sugar pine predominates. Certain small areas, even now, show stands of from 100,000 to 120,000 feet (board measure) per acre, and yet the average of our 100,000 acres is only 13,000 feet. Intelligent forestry should bring this average to 40,000 feet, and can greatly increase the stand of yellow pine on the same general area. The silvical problem is to obtain control of the white fir, so valuable in itself, and so necessary to the future forest, because on account of its hardiness and rapid growth it remains the chief factor in securing great merchantable length of sugar pine stems. The fir must, however, be controlled, and reduced to 20 per cent. of the timber on this area before any large increase in the pine is possible.

THE STANDARDIZING OF LOG MEASURES

EDWIN ALLEN ZIEGLER

Contributed

The present movement in Maine toward a standardizing of the measurement of logs (resulting in the appointment by the Governor of a Commission to report to the Legislature) is not the first statement of dissatisfaction with present log rules. A number of States have made certain rules their legal standard, but the failure of different States to choose the same rule has only added to the general confusion. There are at present between forty and fifty different rules in use in this country. Imagine forty or fifty different bushel measures in use throughout the country; yet that is the condition of log measurement to-day.

Examination of Results by Different Rules for Short Logs Cut in Maine

In 1902 a mill study* was made in Maine with a view to studying the amount of squared lumber actually sawed out of logs of different sizes. Only reasonably straight and sound logs were measured and the product in inch boards recorded. Logs cut into "dimension stuff" could not be included though the larger number of logs went into this material. The following table is quoted from Mr. Tiemann's unpublished report, with his notes on the mills, number of logs, etc.:

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*Conducted by Mr. H. D. Tiemann for the then Bureau of Forestry, U. S. Department of Agriculture.

TABLE I.

SAW CUT OF 12-FOOT LOGS IN MAINE COMPARED WITH THE HOLLAND AND SCRIBNER RULES

Small end diameter inside bark.	*Mill No. 1, Bangor.*		*Mill No. 2, South Gardiner.*		*Mill No. 3, Brewer.*	Holland or Maine Rule.	Scribner Rule.
	Band saw, $\frac{1}{4}$-in. kerf, squared on saw.	Band saw, $\frac{1}{4}$-in. kerf, sawed "alive."	Band saw, $\frac{5}{16}$-in. kerf, sawed "alive."	Rotary saw, $\frac{5}{16}$-in. kerf, sawed "alive."	Gang saw, $\frac{5}{32}$-in. kerf, sawed "alive."		
Inches.	Board feet.	Board feet.	Board feet.	Board feet.	Board feet.	Board feet.	Board feet.
6	22	19	15	13	18	15	14
7	29	27	22	19	25	23	18
8	39	35	29	26	32	33	23
9	48	45	38	34	41	39	30
10	59	55	48	43	50	51	38
11	70	66	59	53	59	62	48
12	83	80	71	65	70	78	59
13	96	93	85	77	82	90	73
14	111	..	100	90	94	107	86
15	127	..	116	..	108	121	107
16	145	..	134	..	122	134	119
17	164	..	154	--	139	154	139
18	185	..	175	..	156	174	160
19	208	..	198	..	176	203	180
20	233	..	222	..	198	227	210
21	261	..	249	..	223	252	228
22	290	..	275	..	249	272	251
23	321	..	...	..	...	300	283
24	352	..	...	..	...	327	303
Basis, (logs of different lengths).	167 logs 28,010 bd. ft.	62 logs 4,120 bd. ft.	224 logs 18,330 bd. ft.	99 logs 3,750 bd. ft.	56 logs 3,900 bd. ft. Mostly hemlock—some spruce.		
	Mostly hemlock, some spruce and pine.		Mostly spruce—some pine.				

The original averages were somewhat irregular on account of the limited number of measurements. These were evened off with no change in the total or average scale. The date of the study (1902) and the tendency to closer sawing in the last few years make the figures comparatively low.

A close examination of the results shows the following facts:

1. Different methods of sawing have a large influence on the cut. "Squaring" the log on the saw gives a larger return than sawing "alive" (through and through), as is shown by Mill 1. This is due to short boards obtained from the part wasted as slab and edging in sawing "alive."

2. A band saw of $^{3}/_{16}$-inch kerf at Mill 2 yields more than a circular saw with $^{5}/_{16}$-inch kerf when sawed "alive." The increase in this case is a trifle over 10 per cent., being exaggerated by the fact that the logs sawed by the band saw were the better logs. This difference for these saws should not be more than 8 per cent. for the same grade of logs.

3. The thinner gang saw gains from its diameter but loses from lack of sawyer's attention to each log. The results are relatively high for small diameters and low for larger diameters.

4. Attention of the sawyer increases output, as shown by the band saws sawing "alive" in Mills 1 and 2. This is increased by a slight advantage in saw and possibly by a difference in taper of hemlock and spruce logs. This closer attention in Mill 1 increased the output per log but decreased the mill output, the band saw in Mill 1 cutting about 39 M feet in an average day (1901) of 11½ hours, while the band saw in Mill 2 cut 58 M feet in 10 hours.

5. The large variation in the saw cut in the same product—inch boards—in the different mills is an important point. This variation would be increased greatly if the contents of the logs in dimension stuff were tallied and compared. If the measurement of logs should be according to the amount sawed out, the question then comes up: what

shall determine the product, inch boards or some specified form of dimension stuff; the amount gotten by the careful sawyer or the sawyer on the "hurry up" mill; the cut of the thin band saw or that of the thicker rotary or circular saw; the cut obtainable from hardwoods or that from conifers?

The Holland or Maine Rule is seen to give a very good indication *for short logs* of the lumber in inch boards obtainable under fair practice. The Scribner Rule is too low for any but inferior logs sawed with a $\frac{1}{4}$ or $\frac{5}{16}$-inch circular saw.

For a comparison with the Blodgett or New Hampshire Rule the middle diameters inside the bark were used after Mr. Tiemann as the basis of Table II, since the New Hampshire Rule should apply at the middle.

Table II compares the New Hampshire Rule with mill cut in Maine on a basis of middle log diameters. While the values for the few first small diameters are about high enough, the values soon run too low and keep getting worse the larger the logs. This is caused by first getting the solid contents of the logs in "Blodgett feet" (about 1.396 cubic feet) and then dividing by the constant factor of 115 (actual practice) Blodgett cubic feet per 1,000 board feet. The same result is gotten if the solid volume of the log is gotten in ordinary cubic feet and 160.5 (1.396 x 115) cubic feet are taken per 1,000 board feet. This fact is commonly overlooked. This calls for $\frac{1,000}{160.5}$ or 6.23 board feet per actual cubic foot of log volume for logs of any diameter. If this ratio is good for small logs, clearly it must be too small for large logs where the slabbing waste is proportionately much less. And this is actually seen in the comparison in Table II.

The Maine Commission's report of January, 1909, recommending that the contents of logs be measured in solid cubic feet at the middle diameter inside the bark, seems very good. But a fixed legal converting factor of 185 cubic feet to the 1,000 board feet would result in a rule *exactly parallel to the present New Hampshire Rule but 15.26 per cent. below it!*

TABLE II.

SAW CUT OF 12-FOOT LOGS IN MAINE COMPARED WITH THE BLODGETT OR NEW HAMPSHIRE RULE

Middle diameter inside bark.	*Mill No. 1, Bangor.*		*Mill No. 2, South Gardiner.*		*Mill No. 3, Brewer.*	New Hampshire Rule.	Solid cubic contents.	*Mill No. 1, $\frac{1}{8}$-in. band saw, logs squared on the saw.*		*Mill No. 2, $\frac{3}{16}$-in. band saw, logs sawed "alive."*
	Band saw, $\frac{1}{8}$-in. kerf, squared on saw.	Band saw, $\frac{1}{8}$-in. kerf, sawed "alive."	Band saw, $\frac{3}{16}$-in. kerf, sawed "alive."	Rotary saw, $\frac{3}{16}$-in. kerf, sawed "alive."	Gang saw, $\frac{3}{16}$-in. kerf, sawed "alive."			Board feet per cubic foot of log.	Cubic feet per 1,000 board feet.	Cubic feet per 1,000 board feet.
Inches.	Board feet.	Board feet.	Board feet.	Board feet.	Board feet.	Board feet.	Cubic feet.	Board feet.	Cubic feet.	Cubic feet.
6	17	15	10	11	16	14	2.36	7.20	139	236
7	25	22	16	16	23	19	3.21	...	...	...
8	33	30	23	22	30	26	4.19	...	...	...
9	42	38	32	29	38	33	5.30	...	...	...
10	52	48	41	37	47	41	6.55	...	...	...
11	63	59	52	46	56	50	7.92	...	...	...
12	75	72	63	57	66	59	9.42	7.96	126	150
13	87	87	76	69	77	70	11.06	...	...	...
14	101	103	90	82	89	80	12.83	...	...	...
15	117	...	104	..	102	91	14.73	...	...	...
16	133	...	120	..	117	104	16.76	...	...	...
17	151	...	138	..	133	117	18.92	...	...	...
18	170	...	157	..	150	132	21.21	8.01	125	135
19	191	...	176	..	170	148	23.63	...	...	...
20	213	...	198	..	192	163	26.18	...	...	...
21	237	...	219	..	216	180	28.86	...	...	...
22	262	...	242	..	241	197	31.68	...	...	...
23	288	...	265	..	...	216	34.62	...	...	...
24	315	...	290	..	...	235	37.70	8.36	120	130

Basis—Same as Table I.

But Table II shows that the New Hampshire Rule is already too low and further that a converting factor giving the relation between cubic feet and board feet must be a sliding factor varying with the diameter of the logs sawed. This is clear from the last two columns of the table based on the cut of Mill No. 1 with a ⅛-inch band saw when squaring logs on the saw. It is seen that the number of actual solid cubic feet of log (*based on middle diameter*) required to saw out 1,000 board feet decreases from 139 in 6-inch logs, to 126 in 12-inch logs, to 120 in 24-inch logs under the best saw practice and the ⅛-inch band saw. Mill No. 2, where speed was the aim and small logs were not carefully sawed (the rotary 5/16-inch saw getting out as much as the 3/16-inch band saw for 6-inch and 7-inch logs), shows a much greater variation in the number of actual cubic feet of log required to saw out 1,000 board feet, being 236 for 6-inch logs, 150 for 12-inch logs, 135 for 18-inch logs, and 130 for 24-inch logs. It begins to approach Mill No. 1 above 12-inch diameters.

This shows that the converting factor varies with diameter and a factor good for 12-inch logs is too low for small logs and too high for larger logs. Further, these figures show that the factor for the New Hampshire Rule—160.5 (1.396 x 115)—and the factor of 185 not only err in being constant, but are much too high for even the smallest logs when carefully sawn and too high for logs 12 inches and over when rapidly sawn with a wider saw.

Examination of Saw Cut and Different Rules for Short Logs in Other States

The Forest Service and several individuals have made a number of mill studies in different States to determine the variation of grades for different diameters of logs and trees and the amount sawed out. These results, without going into grades, shed further light on this question. Unfortunately the diameter of the log was only measured at the small end, hence a direct comparison with the New Hampshire Rule is impossible, except for the practice of applying it at the small end of the log and taking 106 "Blodgett feet" per 1,000 board feet. This is equivalent to getting the contents of a cylindrical log (of the same length and a diameter equal to the small end of the log) in cubic feet and dividing by the reducing factor, 148 cubic feet (1.396 x 106) per 1,000 board feet. The New Hampshire Rule values for the small end of the log in the comparison in Table III were gotten according to this practice. The saw cut refers to 1-inch squared lumber.

Table III again shows that the Holland or Maine Rule is a pretty good indication of saw cut for short logs (12-foot), at least for coniferous species. Yellow poplar seems to run under it by almost 10 per cent. for diameters above 20 inches.

The New Hampshire Rule (applied at the end of log, 106 "Blodgett feet" per 1,000 board feet) is seen to be fair for small diameters but low for larger logs cut from conifers. The fixed converting factor causes the trouble.

Scribner is too low for the conifers and for yellow poplar up to 20 inches and about right for yellow poplar from 20 to 36 inches for the mill practice cited.

Log Rules and Saw Cut for Long Logs

Unfortunately the mill tests quoted before did not include tests on long logs. However, a case in a Texas court (Maryland Trust Co. vs. Kirby Lumber Co. *et al.* Intervention No. 393 in Circuit Court of the United States for the Southern District of Texas at Houston) contains data germane to this point. A special master was appointed to report on points requiring a knowledge of the saw cut of logs under 12 inches in diameter at the small end. For this purpose a mill test was conducted under rigid court supervision with representatives of both sides present. The data were compiled on a basis of the ***smallest diameter outside*** the bark at the small end. Fortunately the larger and smaller diameters inside the bark at the same point were

TABLE III.

ACTUAL SAW CUT FOR 12-FOOT LOGS IN VARIOUS STATES, SPECIES AND MILLS COMPARED WITH SEVERAL RULES ON A BASIS OF SMALL END DIAMETER

Small end diameter inside bark.	(1) Saw cut, Maine, white pine and spruce, band saw, $\frac{3}{16}$-in. kerf.	(2) Saw cut, Ontario, white pine, band saw, $\frac{1}{8}$-in. kerf.	(3) Saw cut, Idaho, Douglas fir, circular saw, $\frac{1}{4}$-in. kerf.	(4) Saw cut, Tenn. and Va., yellow poplar, band saw, $\frac{1}{8}$-in. kerf.	(5) Saw cut, North Carolina, yellow poplar, band saw, $\frac{1}{8}$-in. kerf.	Holland Rule.	New Hampshire Rule (106 Blodgett cubic feet per 1,000 board feet).	Scribner Rule.
Inches.	Board feet.	Board feet.	Board feet.	Board feet.	Board feet.	Board feet.	Cubic feet.	Board feet.
6	15	14	20	...	...	15	16	14
8	29	30	37	35	...	33	28	23
10	48	50	56	55	...	51	44	38
12	71	76	81	75	78	78	64	59
14	100	108	110	100	112	107	87	86
16	134	144	145	135	146	134	113	119
18	175	186	185	175	180	174	143	160
20	222	234	230	215	212	227	177	210
22	275	285	284	265	248	272	214	251
24	...	345	346	310	298	327	255	303
26	...	405	419	365	362	380	299	375
28	...	475	501	425	422	460	347	436
30	...	550	...	485	488	530	398	493
32	...	630	...	550	556	594	453	552
34	...	715	...	625	634	675	511	600
36	...	800	...	700	710	770	573	692

(1) Mill No. 2 quoted from Mr. Tiemann's Study for the Forest Service in Table I. Based on 224 logs (18,330 board feet) not very carefully sawn.

(2) Based on 403 logs in a mill test made by Dr. Judson Clark, formerly Provincial Forester, Ontario, Canada. A small amount of lumber sawed from slabs is not included. Results curved 1 per cent. low under 20 inches, 2½ per cent. high above 20 inches.

(3) Based on a mill test for the Forest Service by Mr. J. F. Bruins; 982 logs followed through the mill. Products other than inch boards were reduced to inch boards with proper kerf deduction. Of the 982 logs 207 were 12-foot logs.

(4) Based on mill test, 4,329 logs, with a cut of 1,500,000 board feet, 90 per cent. yellow poplar, and values rounded to nearest five.

(5) Based on "a thousand tests" by Dr. C. A. Schenck in the Biltmore band mill. "Forest Mensuration," page 8, by Dr. Schenck. This table does not seem to have been evened off.

recorded, so that it was possible to retabulate the results on a basis of the *average diameter inside* bark at the small end, which is given below for 30-foot logs. The results have been made regular by curving on cross-section paper.

Of these logs the special master says: "Fully 75 per cent. of the logs passed under the Special Master's personal supervision before they were sawed at the mill, and to him quite a number of those, which had the smallest diameters, appeared to have been taken from small trees, and not from the small ends of trees that were large at the stump. Consequently, they had *but little or no swell,* both ends being very nearly of the same size."

TABLE IV.

SAW CUT FOR 30-FOOT YELLOW PINE (PROBABLY LONGLEAF) LOGS IN TEXAS COMPARED WITH SEVERAL RULES

Average diameter inside bark at small end.	(1) Saw cut, Texas, yellow pine, band saw (kerf not stated).	Holland Rule.	New Hampshire Rule (using 106 Blodgett cubic feet per 1,000 board feet).	Scribner Rule.
Inches.	Board feet.	Board feet.	Board feet.	Board feet.
6	44	38	40	no values
7	60	58	54	...
8	77	82	71	...
9	97	98	90	...
10	122	128	111	...
11	154	155	134	...
12	193	196	159	148
13	240	225	187	182
14	298	266	217	214
15	364	302	249	268

(1) Based on 196 thirty-foot logs.

This explains the reason for the relatively low saw cut in Table IV below 12 inches. In the 13-, 14-, and 15-inch logs the excess saw cut due to the taper or rise of the long logs begins to become marked. It is safe to say that if the logs of small diameter included a fair proportion of top logs which have more taper the saw cut would have been greater. A number of other species exceed yellow pine in this respect.

Table IV shows the Holland Rule good for 30-foot logs *only* when extremely cylindrical and so small that the slabs will not resaw the minimum boards 3 inches wide. For the larger diameters and logs with considerable taper it will be oversawed.

The New Hampshire Rule applied at the small end again starts fairly high but keeps getting lower and lower on account of the constant converting factor used. The Scribner Rule is also too low.

The longer the logs, the more unfair becomes the use of log rules with no taper allowance. Of course, this can be compensated for by scaling as two or more short logs with the proper increase in diameter.

Saw Cut of Short Logs in Other than Square Edged Lumber

Of course a log rule cannot give anything like a nearly true result for lumber other than square edged inch boards. Table V shows the saw cut of (1) second growth white pine* in boxboards in southern New Hampshire. Seventy per cent. went into 1-inch boards, 30 per cent. into 2⅛-inch plank, 60 per cent. was round edged and 40 per cent. was square edged. (2) Second growth hardwoods cut into 1⅛-inch round edged boards. One-quarter-inch circular saws were used.

The saw cut of this material is seen to exceed the Holland Rule in all cases by from 10 to 20 per cent. or more. The hardwoods cut out less in small diameters than pine, and more in larger diameters.

General Summary

1. The Holland or Maine Rule indicates closely the square edged inch boards that may be sawed out of short logs under ordinary mill practice. Logs over 18 feet must be scaled as two or more logs to guarantee full scale, since

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* From the Mill Study in southern New Hampshire in 1905 for the United States Forest Service by Mr. Louis Margolin.

the rule is applied at the small end of the log and does not allow for taper.

2. The New Hampshire is really a cubic foot rule with a *constant reducing* factor, making the board foot scale nearly correct for small diameter logs but too low for large logs. Applying it at the center of the log (the correct way) and allowing 115 Blodgett feet per 1,000 board feet is equivalent to a cubic foot rule applied at the center and allowing 160.5 actual cubic feet per 1,000 board feet. Applying at center

TABLE V.

MILL CUT OF ROUND AND SQUARE EDGED BOARDS FOR SECOND GROWTH IN SOUTHERN NEW HAMPSHIRE

12-FOOT LOGS.

Diameter inside bark at small end.	Second growth white pine round and square edged boards. circular saw, ¼-in. kerf.	Second growth hardwoods round edged boards, circular saw, ¼-in. kerf.	Holland or Maine Rule.
Inches.	Board feet.	Board feet.	Board feet.
3	7	...	...
4	10	8	...
5	15	11	...
6	21	16	15
7	28	22	23
8	36	30	33
9	46	39	39
10	56	51	51
11	68	65	62
12	81	82	78
13	96	100	90
14	112	120	107
15	130	141	121
16	149	165	134
17	169	192	154
18	189	222	174
19	211	...	203
20	235	...	227
21	260	...	252
22	284	...	272
Basis	1,915 logs	1831 logs.	

would make it good for logs of any length, but the *reducing factor should be a sliding one,* since it takes a larger number of cubic feet in small diameter logs to saw out 1,000 board feet than in logs of larger diameter.

This rule should *never be applied at the small end* of the log, even by dropping the 115 to 106 Blodgett feet per 1,000 board feet. This relation of $\frac{106}{115}$ only holds good when the small end cross section is $\frac{106}{115}$ of the middle cross section. In long logs the end may have a cross section area even lower than $\frac{68}{115}$ of the middle (example: 40-foot log—small end 8 inches, middle 11 inches), in which case 68 Blodgett feet per 1,000 board feet, when measured at the end, would be the necessary factor to equal 115 Blodgett feet per 1,000 board feet measured at the middle. Scaling long logs in short sections would be better than this, but would not be entirely accurate in all cases.

3. No board foot rule is constantly accurate for products varying from 1-inch square edged boards; or for different mills with different saws. It cannot apply to logs used for pulp, for veneer or any other purpose than lumber. The only argument for a unit of log measure which fits only the manufactured product of the lumber manufacturer is that most logs are so manufactured. But how large a proportion of the total log consumption must the pulp, veneer, and stave manufacturers represent before they can demand that logs be measured in pounds of dry pulp, or in staves, or in surface feet of veneer? And in Maine at least are not some of these latter industries considerable consumers of logs?

Why then would it not be advisable to measure the logs by the middle diameter (settling the question of rise in long logs) in cubic feet and sell them by the cubic foot or 100 cubic feet? The pulp man will readily find a converting factor to pounds of pulp to fit his process and conditions. The stave man will readily find his converting factor for staves. And the lumber manufacturer will find his own factor for lumber. This latter will be a sliding factor according to the diameter of the logs and must vary somewhat with kind of lumber sawed, with width of saw, with species of tree, and method of sawing. To say that these manufacturers would have difficulty in establishing such factors would be a reflection on their knowledge of their plants and their efficiency. As well say the beef packer should buy his cattle in units of dressed beef because he is unable to figure closely the loss in dressing. It would be just as fair to the cattleman as the present log unit is to the stumpage owner.

4. Again, the cubic foot unit is one that other States can adopt and finally must adopt to make the measurement of logs uniform over the entire country and for all manufacturers, whether lumber, pulp, veneer, fuel or any other product. Conversion into units like cubic meters in the export trade would be easy.

On the Continent of Europe, logs are sold according to their solid contents—the cubic meter being their unit.

WOOD PRESERVATION—A DETERMINING FACTOR IN FOREST MANAGEMENT

HOWARD FREDERICK WEISS

Contributed

The practical application of forest principles has taken place in the United States in the last decade at an unprecedented rate, because their economic value has been clearly and forcibly impressed upon a responsible American mind. The acceptance and growth of these principles has caused specialization—an inevitable result of all successful arts. Specialization means a concentration of effort upon some concrete work. The preservative treatment of timber may be considered a specialized branch of forestry, and it is the purpose of this paper to show the relation of this specialization to forestry, and how one is an integral part of the other.

Forestry teaches that trees grow according to defined onto- and phylo-generic laws, like all other forms of life, and if these laws are violated, destruction will inevitably follow. A layman, for example, may not understand why the young tulip tree will not grow in his maple grove.

A study then is directed first to find out what are these natural laws, and second, how best to apply them. The greatest progress in this direction has been made in the European countries, and it is there that we find their successful application, as evidenced by the carefully regulated mixed stands of timber.

The utilization of various kinds of timber has shown that some combine more valuable properties for man's purposes than others. A study of these properties has been brought about chiefly through dire necessity. Starting with the cream, man has been forced to the milk. The gums, for instance, classed as "tree weeds" a few years ago, are now eagerly sought and utilized. As a result of these two conditions, namely, the knowledge of the laws of tree growth and the inherent superiority of certain woods for commercial purposes, selected types of forests have been evolved. In other words, man endeavors to eliminate the undesirable species and foster the growth of those best fitted to his needs. The mixed pine and beech forests of Germany may be cited as an illustration.

We have not reached this stage in the United States, but with the ever-increasing intensity of forest management, Nature's combinations will be eradicated, and in their place will be developed man's idea of the society of the select. Nature's law which decrees, "Since no two organisms are alike, one must be better adapted to its surroundings than the other, and the less adapted must sooner or later perish," will be changed to read, "Since no two organisms are alike, one must be better adapted to man's needs than the other, and the less adapted must sooner or later perish." This is simply an illustration from forest ecology, which depicts man's disturbing influence in modifying various forms of life to best meet his requirements. Thus the American forests of the future will be radically different in kind as well as in degree from those now existing. Of the forty odd species of commercial trees now found in the Appalachians, it is safe to say that not more than one-fourth will persist. Certain trees, like the hemlock, will become commercially extinct, simply because it will not pay to grow them. This is not a view into the distant future. The careful selection of species is already common practice in Europe and even now is being actively applied here.

The commercial extinction of certain American woods and the restriction of others is inevitable, and will be brought about because they lack certain specific qualities. These are of two kinds:

1. Silvical—the abundance and vitality of the seed, the resistance of the young plants to insects, fire, and animals, their adaptability to their environment, their rate and character of growth, etc., and

2. Commercial—the size, strength, weight, and beauty of the wood, its ease of workmanship, and its durability.

We are chiefly concerned in this paper with durability. This is a very important property, as proved by the following estimates on consumption:

There are cut each year in the United States, 4 million poles, 150 million cross-ties, 2 million piles, 170 million cubic feet of mine timbers, one-half billion fence posts, and 12 billion shingles, all of which are subject to decay. To these can be conservatively added, 10 per cent. of the lumber cut. From the data on the natural life of these commodities, it is estimated that 8 billion feet (board measure) decay annually. In other words, 8 billion feet must be cut each year for replacement alone. This is 8 per cent. of the total timber, or over 16 per cent. of the total lumber cut. Hence, it is evident that durability is a very important determining factor in governing the demand for forest products. It is the part of wisdom to secure as long a life as possible from the structures you have built. Maintenance charges are thus reduced to a minimum. This is the chief reason why the durable woods have been in such great demand.

The effectiveness of certain preservatives in prolonging the life of wood is no longer in doubt. This conclusion was reached after an exhaustive inquiry by the American Society of Civil Engineers as far back as 1885. Cut timber is increased in life from 100 to 700 per cent., and in certain cases preservation is absolutely necessary. For example, some untreated piles driven in salt water at Texas City, Texas, lasted one month. Treated, they last fifteen to twenty years, and in some cases longer.

In general, the cost of treatment doubles the cost of the untreated wood. Inasmuch as the prolonged life is two to seven times the natural life, the financial saving is apparent. Conditions where it is cheaper to use untreated timber and replace it when rotted are now so few in this country that wood preservation is almost universally applicable.

No method is known whereby all kinds of wood can be satisfactorily treated. Fortunately, however, the species best adapted to treatment are most abundant, and possess certain silvical and commercial properties which give them a decided advantage over others. These properties briefly are: The vitality and prolificacy of the seed, rapidity of growth, and high per cent. of sapwood. The following species may be classed in this group: Bull, lodgepole, loblolly, shortleaf, jack, and scrub pines, cottonwood, red and scarlet oaks, silver and red maples, buckeye, black and cotton gums. All of these, with the possible exception of the bull and shortleaf pines, are commonly classed as "inferior" species. When a timbered area is cut or burned over, these are the commercial species which usually first come in to reforest it. It should be noted that their rate of growth soon culminates. None of them are long lived, and none of them have durable wood. It is not necessary to go into a discussion of their silvical and physical properties, as the generalizations cited are sufficient. The inherent characteristics of these trees are such as to render forests composed of them easy to propagate and manage.

It is the practical application of these principles which furnishes one of the direct connections of wood preservation to forest management, and the chief purpose of this paper. Suppose that an individual or company has a tract of denuded land upon which it is decided to grow timber. Should slow or rapid growing species be planted? Which will pay better? Almost invariably the wood of the former is more durable than that of the latter, but if figured on the basis of annual financial profit, the advantages are usually in favor of the latter. An example may be cited: Loblolly pine in an index stand, on a 70-year rotation, will yield about 33,000 feet (board measure) per acre; longleaf pine under the same conditions, on a 120-year rotation, will yield about 25,000 feet (board measure). Assuming the value of the land and the cost of planting at $10 per acre, taxes 3 cents, fire protection and management 2 cents per year, and interest 4 per cent., the total cost of the loblolly at the felling period will be $174 and longleaf $1,244 per acre. The future stumpage price of these species can only be predicted, but at the time the crops would be harvested, suppose the value to be $8 per thousand feet (board measure) for loblolly and $13 for longleaf, or an advance in present prices of over 300 per cent. for loblolly and 400 per cent. for longleaf. The value of the crops will then be respectively $264 and $325, or a total profit of $90 for the loblolly and a deficit of $919 for the longleaf. Longleaf, in order to produce a profit equal to the loblolly, would have to be worth about $54 per thousand feet stumpage. At such a price, it would be commercially prohibitive. It is not at all probable that American business men would sink their money into a project of this kind, for under such conditions longleaf can be grown only at an economic loss. Similar examples would be found to exist if other of our slow growing and more durable woods were compared with those listed in the so-called "inferior" group.

Exceptions, of course, occur, notably with such species as black locust, catalpa, osage-orange, chestnut, and eucalypts, which combine durability with rapidity of growth. But a glance also reveals that these trees are of small size or poor form, or are subject to insect or fungus attack, or are decidedly limited in distribution. Thus, black locust is attacked so severely in early life by borers, that the wood is practically destroyed and the weakened tree rendered unfit for most commercial uses. On account of this insect, the practical range of the successful production of locust is very limited.

The catalpa demands a deep, rich, loamy soil, which causes it to encroach upon areas better suited for agriculture. Moreover, it so frequently branches in the trunk that it can be used only for the smaller products, such as posts, and possibly ties, and rarely for lumber or poles.

The osage-orange is of such form that it is used almost exclusively for hedges. Moreover, it does not grow to sufficient size to furnish a product larger than posts, and although these are very durable, they usually make a very crooked fence line.

The chestnut combines form, rapidity of growth, and durability, and is one of the most valuable eastern woods. Lately, however, a bark fungus has taken such a hold upon it that it threatens its complete destruction. As extensive remedial measures cannot be as profitably taken in protecting forest trees as are taken with fruit trees, but unless the ravages of this fungus are checked, it is feared the chestnut will become commercially extinct.

The eucalypts are other soil exacting trees. Moreover, they can only be grown localized in the almost frostless portions of our country.

Whenever these species can be profitably grown, their extension should by all means be encouraged, because they combine many of those qualities demanded by men and their subsequent treatment with preservatives is not a necessity.

Some may claim that the cost of planting the land in the example of the pines cited is too high. So let us assume that the land is worth only $1 an acre and that the same yield will be maintained by natural reforestation. Hence there will be no cost for planting. Moreover, we will assume that there is no charge whatever for protection. It is usually argued that the land is worth nothing except for timber, and private individuals do not have enough initiative or give enough consideration to posterity to cause them to spend money for replanting and managing it. It is extremely unlikely, however, that under these conditions fully stocked stands will be obtained. But granting that they are and that the yield of loblolly is 33,000 feet (board measure) and the longleaf 25,000 feet (board measure) per acre, the cost of the crops per acre will then be $26.50 for loblolly and $192.91 for longleaf, or net profits respectively of $237 and $132, with an excess of $105 per acre for loblolly pine.

These profits revert to the producer of the timber. Wood preservation assists him because, as we have shown, it enables him to readily and profitably dispose of his inferior products, which without treatment would have a much less value. In other words, it creates a market for him, and thus offers an incentive to grow such timber. But how does the consumer, the man who is directly concerned with the durability of his materials, gain as a result of timber preservation? Broadly speaking, he does so in two ways: (1) He secures his raw material at a lower price; (2) Chemical injection so prolongs its length of service that it is much cheaper to use it treated than the most durable and valuable woods untreated. To illustrate: A common price for an untreated red oak tie is 45 cents and for a white oak 70 cents. He therefore saves 25 cents on the initial cost of the tie. The white oak untreated will last in the track about ten years. Based on the usual cost of maintenance, such ties will have at a 4 per cent. interest rate an annual charge of 9.8 cents. Red oak, Bethalized, will last sixteen years, and have an annual charge of 7.6 cents, or produce a net annual saving of 2.2 cents per tie, or about $55 per mile. These figures are taken from Brush's report prepared for the Lackawanna Railroad in October, 1906. In extreme cases, such as piling in teredo waters, the saving due to timber treatment is so great that it is imperative to treat. Who would build a pier if it were going to be chewed to pieces in three months?

If a plantation is started with, say 1,200 trees to the acre, it is safe to assume that not more than 17 per cent., or a total of 204, will remain for the final crop. Those removed will necessarily have been cut in the several thinnings, while the trees were yet immature and possessed a large per cent. of sapwood. The revenue derived from such thinnings is usually based on the fuel value of the wood. Such small trees, however, if cut for posts or even poles, and treated, will have their value appreciably augmented, so that thinnings can be made to yield a larger income. Suppose the above stand is loblolly and the first thinning is made at twenty years, 600 trees per acre being removed. These will be about 3 inches in diameter and 20 feet high, hence too small to be used advantageously even for fuel. The first thinning will therefore represent a direct apparent loss, which, however, will more than be recovered by the accelerated growth of the remaining trees. The second thinning will be made at forty years, and 400 trees will be removed. These will by this time have reached a diameter of 8 inches, and a height of 45 feet. If cut for fuel, they would yield about $13 for stumpage, worth for this purpose about $1 per cord. If cut into posts, however, they would yield about 1,600 worth at 2 cents each stumpage a total of $32. Posts of this species, or more generally of inferior species, are worth little, unless treated, but when treated their durability will equal or exceed that of the more costly varieties, and as their annual maintenance charges will be less it will be cheaper to use them. Increased profit derived from thinnings will enable these to be systematically and carefully made, and thus the application of a more intensive system of forest management is made possible. The practicability of a working plan depends very largely and in some cases entirely upon direct financial returns, and in any case, if the plan can be made to produce such returns, it will enable forest principles to be more readily applied.

A similar condition, as in the case of thinnings, also occurs in the utilization of the top logs in the final crop. Thus the top logs of such trees as the yellow poplar, black walnut, cherry, birch, etc., possess such little value that they are often left in the woods to rot, or when sawed into lumber are frequently sold at a loss. For example, the value of lumber cut from yellow birch logs in the Adirondacks in 1904, 14 inches or less in diameter, was $9.37 per thousand. The cost of stumpage, logging and manufacturing was at the lowest figure $10.50 per thousand. The operators, therefore, lost $1.13 per thousand, on all logs removed. For beech, the loss amounted to $1.80 per thousand feet (board measure). If these logs had been cut into standard railroad ties, they would, at $5 per thousand stumpage and 15 cents each for logging and marketing, have cost about 32 cents each and sold for 45 cents each, or a net profit of about $3.90 per thousand feet (board measure).

Untreated ties of this species have little demand and value on account of the large amount of sapwood they contain, which causes them to decay quickly. They are excellent, however, for preservation treatment. In fact, beech ties, when decay is eliminated, make about the best ties that can be obtained. Some companies are beginning to realize the important part wood preservation is playing in the utilization of these smaller hardwood logs. The Chicago & North Western Railroad has just spent over $30,000 to remodel its treating plant at Escanaba, Mich., so that it can handle hardwood ties. What is true for hardwoods is also true, although to a lesser extent, for softwoods. But the important fact is that wood preservation, eliminating decay, enables the small sappy logs to be used to much better advantage than if sawed into lumber or cut into cordwood. This feature is worthy of consideration, also, in a discussion of questions relating to tariff revision. An effective system of forest management, therefore, will recognize this, and will change the system of harvesting the crops, so as to get the greatest profit from them. As mentioned, such recognition and action have even now been made, and it is reasonable to claim that they will increase in importance with the future forced intensity of forest management.

A temporary although important connection in which wood preservation affects forest management is in the utilization of dead timber. Dead timber, whether standing or down, decreases in value each year, and land encumbered with it can be likened to a capital stock earning no dividend, but compelled to pay heavy annuities. There are thousands of acres of just such land in the United States. The timber on it has been killed by fire, insects, or fungi, and is deteriorating in value. This timber is usually left to rot, but in a few cases is cut and sold, mostly for fuel and more rarely for ties, posts, or props. As fuel value is generally the lowest value, it is efficient management to utilize the wood for other purposes, if possible. It is often impracticable to use such trees for high-grade lumber, because of their extensive checks, the stained condition of the wood, or holes bored by insects. They can, however, be profitably employed for such commodities as props. Their seasoned condition makes their wood so much lighter than green wood, that it can be transported more cheaply, and it is also rendered more durable. These, therefore, are distinct advantages, the seasoned condition especially so, if the wood is to be given a preservative treatment. But on account of the rapid decay of much of this timber, even when seasoned, it has been little used, except for fuel. Tests made by the Forest Service on fire-killed lodgepole pine in Idaho proved that it was in ideal condition for preservative treatment, and that when the wood was cut for treatment, its stumpage value was raised about 60 per cent. The Service has begun to treat dead timber on some of the National Forests, and is experiencing little difficulty in disposing of it to advantage. This phase of the problem is cited to show how wood preservation enables a more rapid disposal of dead timber and thus paves the way for a quicker reforestation of the areas which contain it.

To recapitulate—Wood preservation affects forest management in four ways:

First. It will govern the composition of certain production forests. These forests of the future will be composed of species possessing such silvical and commercial properties as best fit man's wants, and will be grown for specific purposes. White oak will be as rarely used for ties as black walnut now is for fence rails. In the selection of species, man will choose those which will yield him greatest financial profit. Wood preservation mitigating decay, will enable him in many cases to obtain largest returns by the propagation of certain rapid growing but not naturally durable woods. Hence, future stands will be composed of those species whose wood without the application of a chemical treatment would have such a limited demand that they could not be grown at an economic profit. This condition applies especially to railroad and mining companies, and to others who consume large quantities of construction timber. Even now, some of them are practicing this principle.

Second. Wood preservation enables the trees removed in thinnings to be put to a higher use than for fuel, and by so doing enables these to be more systematically and effectively made.

Third. Other things being equal, conservative lumbering pivots upon the value of the top logs. Change this value, and you change the system of marketing. Wood preservation enables the small sappy logs to be used to better advantage than if left to rot in the woods, or sawed into lumber and handled as the more valuable grades. By raising their value, it intensifies the utilization of timber and fosters its more conservative use.

Fourth. Wood preservation accelerates the removal of dead timber, and enables areas so denuded to be more speedily reforested and placed upon a profitable basis.

FOREST MAPPING AND TIMBER ESTIMATING AS DEVELOPED IN MARYLAND

FRED W. BESLEY

Contributed

There has been for several years an increasing demand for a timber census, in order that we may know more definitely the amount and condition of the standing timber of the country, and thereby be better able to regulate production to meet future needs. A number of States have recently organized for forestry work, and naturally the first step in formulating a forest policy, or shaping legislation (if it is to be done intelligently), must be based upon a knowledge of existing forest conditions and needs. It is true that various methods have been used in different places for the purpose of ascertaining the stand of timber, but in nearly every case the estimates have been based largely on meager and indirect information, possessing little if any permanent value. There is, therefore, an imperative need for some rapid method of mapping and classifying the forests, to include a careful estimate of the stand, which at the same time shall not be too expensive nor too complicated for general application.

This paper is offered for the purpose of showing what has been accomplished along this line in Maryland, in the belief that it may have suggestive value at least for similar work in other States.

Conditions Presented

In the summer of 1906, after the newly created State Board of Forestry was organized and the writer became identified with the Maryland work, the most urgent need was to ascertain as accurately as possible the forest resources of the State. Previous to this time, forest maps for a few of the counties had been prepared by the Federal Forest Service in coöperation with the State Geological Survey. With the exception of one county, no attempt was made in these maps to classify the forest lands and therefore there were not sufficient data for estimating the stand. In the one county where the forest lands were classified, there is lacking information as to the average stand of the classes, thus making it impossible to arrive at a careful estimate of stand for the county. While these maps have not contributed data that could be used for the detailed work now in progress, the reports accompanying them have furnished useful information in calling attention to the general conditions in the State.

Good county topographic maps have been published by the State Geological Survey for all except three counties, and the field work for these is now under way, so that in a short time topographic maps will be completed for the entire State. These maps are used as base-maps on which to sketch the forest areas. In States where no such base-maps are available, careful forest mapping must be difficult and expensive.*

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* In the summer of 1904, while the writer was a member of a party studying the forest conditions on the Pike's Peak Forest Reserve, he suggested and aided in carrying out a method of forest mapping suited to mountainous conditions where no topographic maps were available and section corners were known. In brief, the method consisted of running parallel compass lines one mile apart from known section corners, usually on the township line, in both a north-south and east-west direction. In running the first set of parallel lines the approximate location of each section-corner was determined by stepping along the line when possible, otherwise estimating the distance. The line was blazed in the vicinity of the section corner, as estimated by distance traveled. In many cases the section corners were found in this way. The mapping was done while running the cross lines. The line was run by a compass-man and a rodman, who kept the distance by stepping and established temporary section corners at the intersection of the lines if the original corners could not be found. The map-man checked up on these corners, sketching and classifying the forests as he went along.

Plan of the Work

The purpose of the field work is, first, to locate and sketch on the base-map each wooded tract; second, to classify each tract, or part of tract, according to its condition; third, by means of a number of sample plots in each type or class, to arrive at the stand of timber, representation of species, etc., for each type; fourth, collection of data as a basis for a report on the forest conditions.

Preparation for Field Work

It is not generally known that the United States Geological Survey, in the preparation of their topographic maps, sketch in on their field sheets the outline of the wooded areas. Only a few of these sheets have been published, though nearly all of them have been reduced to the publication scale and are available for copying at the office in Washington. The writer was the first to make use of these woodland sheets in the preparation of forest maps, and he has found that where the woodland sheets have been made within the last ten or twelve years, they are accurate and reliable, more so in fact than are the forest maps made by reconnaissance surveys where only the forest areas are under consideration. Where a forest map is to be made and the classification of woodlands is not required, the work can be done very quickly and at slight expense, by tracing these woodland sheets and transferring them to the corresponding topographic sheets of the area to be mapped. This, of course, is only possible where the Government topographic surveys have extended and where the woodlands have been sketched in by the Survey. For most of the counties of the State such woodland sheets were available, and as a guide to the field mapping these wooded areas were traced lightly on the county map to be used. The map was then cut into sections, each approximately 6 by 9 inches and mounted on a large sheet of muslin. This makes a field map that will stand much handling without injury, and since it can be folded in almost any shape desired, it is very convenient for field use and easily protected from the weather.

Field Work

Organization.—The mapping of an entire county is assigned to one man, who works alone with the exception of the time spent in taking sample plots, when he is assisted by the man in charge of the field force. The chief of field work, or inspector, divides his time among his assistants in taking sample plots and collecting data, and exercises close supervision over their work. This is necessary, to standardize results and to insure uniformity in the classification of the woodlands for the entire State. One inspector cannot satisfactorily look after more than three assistants working in adjoining counties. Where the conditions are extremely variable necessitating the taking of many sample plots, two assistants are all that can be worked to advantage.

Making the Map.—The map-man, provided with his field base-map, enters the county at a convenient point, working from place to place in regular order over the entire county. Unless he has had considerable experience in estimating and measuring distances, and in checking his estimates by stepping or measuring, it is better to spend the first few days in mapping on foot. After once becoming proficient in estimating distances, a more rapid mode of travel is required. In a county where the roads are fairly good, a horse and buggy is the best conveyance. In mountainous sections, where the grades are heavy and the roads rough, traveling on horseback is preferable. An odometer attached to the front wheel of the buggy, and placed so as to be conveniently read from the buggy seat, is a very useful instrument in mapping work. The one reading to one-hundredths of a mile is the best for the purpose. This instrument is not only very accurate and useful in measuring distances from a known point to the edge of the woods, the width of wooded areas along the roads, etc., but is also valuable in keeping a check on the distance traveled. A scale can be easily devised that will transpose odometer measurements to those on the map scale.

In estimating distances, the rod is the most convenient unit of expression, and since the Geological Survey maps are on the scale of one mile to the inch, it is easy to transfer distances in rods to the map scale. It is not generally possible to map with accuracy more than one-half mile each side of the road; and it will be found necessary to travel practically all of the public roads and many private roads in order to get as close to the woodlands as is necessary to correctly classify them, and to view each tract from as many different angles as possible for a check on location. On the topographic base-map where houses, streams, crossroads, and contour lines are located, the outline of the woodlands can be sketched with sufficient accuracy in relation to these known points. The odometer measurement will be a further check where a question of distance along the roadside is to be determined. Each tract of five acres or more is mapped and classified from the nearest points (local information as to character and condition of stand gathered from residents being used to some extent).

The scheme of classification should be one of sufficient range to include every distinct type, or class of the type, and be a uniform one for the entire State. The basis of classification used in Maryland is primarily the present stand of timber, independent of the quality of site. The two main divisions are the hardwoods and the pines. The hardwoods are almost invariably of a mixed class and are divided into the merchantable class, the culled class, and the saplings. The merchantable class of hardwoods is further subdivided into three divisions, known as the first, second, and third, depending upon the stand per acre. Likewise the culled class is subdivided into three divisions, depending upon the stand. The saplings represent only the beginning of a growth, including trees up to twenty feet in height. The pines are divided in a similar manner. Swamp lands are separated from the uplands on the base-maps.

Sample Plots.—Sample plots are taken at different points in the county and in the different classes of woodlands. The number required depends upon the variations of classes and the degree of accuracy required. The average in the Maryland work has been at the rate of one for each ten square miles. Sample plots taken in one county may be utilized in another county where conditions are similar. A convenient size for the plots is four-tenths of an acre, which makes a square 132 feet long on each side. This is about as long a sight as can be taken on uneven ground, and through the average woodland, without much brushing out.

Two men are required to take the plots. The instruments used are an angle mirror, a fifty-foot tape, a pair of calipers, and a height measure. If only the merchantable stand of saw timber is required, it is sufficient to caliper only trees above ten inches in diameter. Where the growing stock and full representation of species is required, all trees should be calipered down to a diameter of two inches. This was done in the Maryland surveys. As each tree ten inches in diameter and over was calipered, its volume in board feet was read off from volume tables arranged in height classes, the height of the tree being estimated and discounts for unsoundness made when required. Heights were measured occasionally to check up the ocular estimate. The stand on the sample plots of the same class, averaged together, served as the basis of calculating the yield per acre of the class.

The plots were carefully selected by the map-man, under the supervision of the inspector, and in addition to their value as determining the average stand, they served a very useful purpose in checking up frequently the ocular estimates, thus making the map-man more proficient. The inspector, by dividing his time between two or three map-men, is able to secure a good distribution of the sample plots over each county and at the same time keep in close touch with the mapping performed by each man. The taking of sample plots and the mapping naturally proceed together, though on the days when sample plots are taken, the map work does not progress as rapidly as ordinarily. The average time required to take a four-tenths acre sample plot is about forty minutes.

At the end of a day's mapping, or as often as twice a week, the map-man makes tracings from his field map, indicating the outlines of each wooded tract and its class, and mails them to the office, where they are transferred to the flat office map. Deficiencies in the field work are discovered in making the tracings and remedied before the map-man leaves the field. This plan results in a duplicate copy of the work.

Collecting Data.—In going over a county in detail, as is necessary in preparing the forest map, there is the opportunity to gather full information concerning the uses of the forest and other data on which to base a full report, thus making at one time a complete study. These data are collected by the inspector, supplemented by the facts gathered by the map-man, who is provided with the following outline covering the subjects to be considered:

OUTLINE FOR COUNTY STUDY

1. Location and class of each tract.
2. Description of forest types as distinguished on the map.
3. Sample plots to represent each type.
4. Changes in woodland area—past and prospective.
5. Damage to forests—cause and effect.
    - (a) Fires—attitude of owners—need of wardens.
    - (b) Grazing—attitude of owners—fence laws.
    - (c) Methods of cutting—effect.
    - (d) Insects—kinds and damages.
    - (e) Fungi.
6. Forest Industries.
    Lumber, cordwood, pulpwood, poles, piles, railroad ties, mine props, charcoal, staves, veneer, fence posts, shingles, etc. Under each of above give:
    - (a) Species used and amount.
    - (b) Stumpage value and price delivered.
    - (c) Where shipped and how.
    - (d) Names of individuals or companies operating.
7. Transportation Facilities.
    Roads, railroad, water.
8. Market Conditions.
    - (a) Kinds of produce in demand.
    - (b) How material is handled.

    (c) Possible extension of market or demand for material now unmerchantable.

9. Forest Management.
    (a) Cause of present condition of woodlands.
    (b) Attitude of owners toward improved methods.
    (c) Improved methods of handling woodlands.
10. List of tree species.
11. Selected list of woodlands owners.
12. Names of those who have set out commercial tree plantations, and who have accomplished something in forest management.
13. Miscellaneous information.

Cost of Field Work.—Under average conditions in any county, where there are plenty of fairly good roads and the surface is not too undulating, the map-man can cover about twenty-two square miles per day. A safe average, including the taking of sample plots and the necessary doubling back over the same ground, would be about eighteen square miles per day.

The cost is determined by the salaries paid, expense of team hire, and subsistence. In mapping 3,840 square miles in Maryland during the past two seasons, the average cost, including sample plots and salary of inspector at $5 per day and with two assistants, has been fifty-four cents per square mile. During the past season, when the work was better systemized, the cost per square mile was fifty-one cents. This is believed to be a conservative estimate for almost any of our eastern States.

Office Work.—By using field maps of the publication scale, the expensive drafting details are eliminated, and it is simply a matter of tracing the wooded areas from the field map and transferring them to the final office map. The different classes of woodland are represented by colors and initial letters. To reduce publication costs, as well as to simplify the scheme, only two colors are used—red to represent the hardwoods and green to represent the conifers. The different classes of hardwoods and of conifers are represented by solid colors, heavy or light horizontal lines, or by diagonal lines, and in each area there are initials to further designate them.

The hardwoods are divided into three main classes, depending primarily on the possible cut per acre, designated as merchantable (M), culled (C), and saplings (S). The divisions are arbitrary, but in our classification a merchantable stand is one where the cut of saw timber, ten inches and over, will run 3,000 per acre or more. The culled class includes all stands cutting less than 3,000 feet per acre and above the size of saplings. The sapling class represents all stands of at least three-tenths the normal density, from one foot to twenty feet in height, and with trees under four inches in diameter. The merchantable hardwood class is further subdivided into three sub-classes, designated as M^1, M^2, and M^3, in which M^1 represents the maximum stands above those with a cut of 15,000 feet per acre; M^2 those yielding from 8,000 to 15,000 feet, and M^3 those from 3,000 to 8,000 feet. The culled class is also subdivided into three sub-classes, C^1, C^2, and C^3. The sub-class C^1 represents a stand that will cut from 2,000 to 3,000 feet per acre. The distinctions C^2 and C^3 are largely based on density of stock and height of stand rather than on cut, though in averaging up the sample plots each of these classes named shows a small cut per acre.

The conifers are divided into two general classes, merchantable and sapling. The culled class is omitted because pine, which is the only conifer of consequence in Maryland, is merchantable at a much lower diameter than are hardwoods, hence the number of sub-classes under Merchantable are increased to five. Where mixed stands of hardwoods and conifers occur, they are shown on the map by combinations of colors and initials. Thus a combination of merchantable pine of class 2, over culled hardwoods of class 3, would be represented by a solid green background with heavy horizontal red lines, and would bear the initials P^2C^3. The pines are separated by species with distinctive initial letters, as for example P (pitch), S (scrub), L (loblolly). It is evident that a simple scheme of classification can be easily devised to meet any condition that may be presented.

After the office map of the county is completed the next step is to measure with a planimeter the individual areas of each class represented. Each area is recorded under its proper class and the total of each class determined for the county.

The stand of saw timber of each class is obtained by averaging the sample plots of the class, reducing the average to the acre unit, and multiplying the acre-stand by the number of acres represented in the class. The stand of all classes is obtained in the same way and their combined stand gives the total amount of saw timber for the county. When selecting and taking the sample plots, it will be observed at the time, and so recorded, that some are more representative than others. In working them up for averages, these differences may be equalized by giving each a relative weight according to the degree of its representative character, noted at the time the plot was taken. The same plots and a similar method is used to determine the growing stock and representation of species of each class.

There are apt to be slight variations in the average yield of stands of the same class in different counties, due to the personal element in classifying, and also to differences in the representation of species. This tendency, however, is reduced by taking a great many sample plots under the same supervision and requiring the map-man to check up his ocular estimates frequently. The representation of species in each county also varies, due to differences in local conditions.

Permanency of Forest Maps

It is obvious that a forest map made ever so correctly now will not correctly represent conditions ten years hence. Changes in the woodlands brought about by lumbering, fires, clearing land, old fields growing up, and increment will require frequent revision to keep the maps up to date. In the older States like Maryland changes brought about by clearing land and fields allowed to grow up are not great, but other changes are considerable and present a real difficulty. To solve this problem it is proposed to use the forest wardens for the revision work. Under the Maryland fire laws forest wardens may be commissioned by the Governor, on recommendation of the State Forester, in all parts of the State where needed, the number not being limited. Each warden is also required to present to the State Forester an annual report of forest conditions in his district. A printed forest map of his district is furnished each warden and on this map he is to indicate, according to specific directions, the changes that have taken place during the year. This revision will accompany the annual report to the State Forester and be transferred to the office map, so that, at least, may be kept up to date. The published maps may also be revised from time to time and republished as the need arises.

While as yet (May, 1909) forest surveys have extended over but half of the State, the value of this first-hand personal investigation has been proven beyond a doubt. Aside from the results as shown in published maps indicating to timber buyers and others who are interested just where certain classes of timber are to be found, it gives to the State Forest Service an intimate knowledge of conditions that could be obtained in no other way.

A METHOD OF STUDYING GROWTH AND YIELD OF LONGLEAF PINE APPLIED IN TYLER CO., TEXAS

HERMAN HAUPT CHAPMAN

Contributed

The ultimate aim of studies of growth is to determine the amount of material that can be grown per acre in a given time—in other words, a yield table. These are the data most difficult to secure and for many species they have not yet been worked out.

Yield tables are usually classed as normal when an effort is made to determine the yield which a site is capable of producing when stocked to its full capacity, and empirical or average when the figures represent the actual yield of wild forests, which theoretically yield much below the normal capacity of the soil. It is agreed that a normal yield table should give results that are fairly constant for the same quality of site, and which may be attained in the future under forest management by securing full stocking and preventing losses by fire and other natural agencies. Empirical yield tables, on the other hand, show what the forest has actually produced under existing conditions.

There is no questioning the value of a normal yield table, but normal yields, so-called, are not necessarily a fixed quantity. Normal density is taken to mean complete stocking, or full utilization of the soil and crown space, but this would characterize stands which might vary over wide ranges in the number of trees per acre. Since the size of the individual tree greatly affects the yield of sawed lumber, stands with the same cubic contents and full density will differ widely in yield if expressed in board feet, the difference being always in favor of the stand with fewest and largest trees.

The second factor of yield, namely age, brings out great differences in yield from similar sites and species. If a stand is densely stocked from the seedling stage to maturity, the natural struggle between individuals is often unnecessarily severe and prolonged. The poorer the soil and the more intolerant the species, the greater the damage that will be done to the growth of the stand; a damage not at all compensated for by improved pruning and greater clear length. Beanpoles are not as profitable as two-inch planks, even if the latter are knotty. Whether occurring naturally, or by artificial thinning, a stand is benefited by the prevention of this struggle, and the age of maturity will be greatly lessened and production of saleable material much increased in the more open stands. The drawbacks of too open stands, namely, too spreading a crown, loss of height growth, and large knots, are more pronounced the more tolerant the species.

There is, therefore, a danger that in the selection of plots for a normal yield table, stands will be taken that are overstocked. This danger is greatly increased in small plots, where a common mistake is to include more stems than is normal, the crown space of the included trees occupying more space than the area of the plot, which makes the yield too great. But, with due regard to density and size of plots, useful figures may be obtained for any species which customarily grows in pure even-aged stands.

The longleaf pine is found in pure stands but seldom even-aged. Although an extremely intolerant tree, which will thrive best in even-aged stands, the natural form of this forest constantly trends toward small, even-aged groups of a few hundred square feet. Being naturally resistant to fire, large clearings never occur from this cause. In regions of severe winds, or tornadoes, larger even-aged patches and strips are found, sometimes one-quarter to one-half mile in width, which have come in after blowdown. These are pretty well interspersed with patches or single survivors of the old forest which have acted as seed trees.

It is, therefore, somewhat difficult to select good sized plots with any assurance that the trees are of the same age. In form, the forest is naturally quite open. Many glades occur, and the older timber is never found in stands which approach what we have been used to considering full density. The problems to be solved in getting figures on yield of longleaf pine in Tyler County, Texas, were therefore:

1. The separation of the age classes and determination of the yield per acre and age of each.
2. What constitutes the normal, or possible, yield per acre of the species and how far this differs from the actual yields obtained.

Since the main object of the study was to get average or actual yields, very large plots could be taken. The size of the plot used was forty acres, and the growth and yield was determined on nine plots, or 360 acres. The average stand per acre was 9,450 board feet, which is a good maximum yield on large areas of pure longleaf lands in this portion of Texas.

Theoretically, in such forests of mixed age classes, one could only get accurately the actual yield per acre of the different age classes in a plot by determining the volume and age of each tree and the space it occupies. If the trees are grouped in small age classes, the determination of area occupied is simplified. But the labor involved in this procedure, necessitating measurements before and after logging the plot, makes it impractical.

The plan adopted made it unnecessary to determine the age of any of the standing trees, and while several steps in the method may appear somewhat arbitrary, the results as well as the simplicity of the work apparently justify the scheme.

The accuracy of the figures was made to hinge first upon two sets of data:

1. Stand tables of the 40-acre plots.
2. Growth of average trees based on age.

The forty-acre plots were calipered in inch classes at breast height, and each tree blazed to prevent error. Great care was taken to get the actual merchantable heights of the trees. Since the forest varies greatly in density, the merchantable heights of the trees vary much more than their total heights based on diameter. At least 20 per cent. of the trees were measured by hypsometer at the point where the upper merchantable limit occurred, this being based on present actual practice in the vicinity. From these data the remaining heights were determined separately for each diameter class, basing them upon the heights actually measured in that class. A local volume table based on the actual scaled contents, Doyle rule, of 400 trees in eight-foot merchantable height classes was used to determine the yield.

TABLE I.

VOLUME TABLE, BOARD FEET, LONGLEAF PINE, TYLER CO., TEXAS; FROM ACTUAL USED, SCALED CONTENTS OF 400 TREES, 16-FOOT LOGS, DOYLE RULE, DIAMETER LIMITS 8-INCH TO 20-INCH TOPS, VARYING WITH SIZE OF TREE

D. B. H.	2 log.	2½	3 log.	3½	4 log.	4½	5 log.
12	65	75	85	...	...	...	...
13	80	95	105	120	135	...	...
14	90	110	130	150	170	...	...
15	105	130	155	180	205	235	...
16	125	155	190	220	255	290	...
17	150	185	220	260	300	340	...
18	175	215	260	300	350	390	430
19	200	250	300	350	405	455	500
20	230	285	345	410	465	525	580
21	265	330	395	460	530	600	665
22	...	375	445	525	600	680	750
23	...	410	500	590	670	750	835
24	...	...	570	670	760	850	935
25	...	...	640	740	845	940	1,035
26	...	...	725	830	940	1,040	1,145
27	...	...	825	930	1,040	1,150	1,265
28	...	...	915	1,030	1,150	1,270	1,390
29	...	...	995	1,125	1,260	1,390	1,525
30	...	...	1,080	1,220	1,360	1,510	1,665
31	...	...	....	1,320	1,480	1,640	....
32	...	...	....	1,430	1,600	1,750	....
33	...	...	....	1,540	1,710	....	....
34	...	...	....	....	1,840	....	....

The form of the tally made it possible to compute the volume of each diameter class and height class separately.

The figures of growth were taken from fresh stumps cut on adjoining tracts with the same type and soil conditions. The object of the table of growth was to give the age of an average tree of any size in stands of 100 to 300 years old. A curve made from stumps taken to cover all sizes of trees found in merchantable timber, and based on age of tree, will give these data as accurately as is possible. The proper correction should be made to reduce the growth to terms of diameter at breast height so as to apply to a volume table based on diameter at breast height.

TABLE II.

FORM OF STAND TABLE FOR 40-ACRE PLOTS, USED IN STUDY OF GROWTH PER ACRE, NUMBER OF TREES SHOWN FOR EACH DIAMETER AND HEIGHT CLASS, TYLER CO., TEXAS

D. B. H.	2 log.	2½	3 log.	3½	4 log.	4½	5 log.	Total number of trees each diam. class.
12	65	39	26	..	..	..	..	130
13	34	35	34	12	..	..	..	115
14	34	55	28	14	7	..	..	138
15	17	41	28	17	11	..	..	114
16	11	22	33	22	22	..	..	110
17	..	18	27	23	18	5	..	91
18	..	10	25	31	31	5	..	102
19	..	4	8	29	33	8	..	82
20	..	..	9	26	31	22	..	88
21	..	3	7	22	25	11	3	71
22	..	..	6	30	12	6	6	60
23	..	2	11	11	7	4	2	37
24	..	..	3	8	14	3	..	28
25	..	..	5	6	8	3	6	28
26	..	..	4	4	8	4	..	20
27	..	..	1	3	4	2	..	10
28	..	2	1	2	4	2	..	11
29	..	..	..	2	1	5	2	10
30	..	..	..	2	3	3	2	8
31	..	..	..	..	2	2	..	4
32	..	..	..	..	2	2	..	4
33	..	..	1	..	2	1	..	4
34	..	..	1	..	1	..	..	2
35	..	..	..	..	..	1	..	1

Total stand per acre, 10,350 feet.
Total number of trees on plot above 12 inches, 1,268.

To apply these two classes of data in the determination of yields per acre based on age, the following steps were taken:

1. Four age classes were adopted.
    - (a) Veterans.
    - (b) Mature.
    - (c) Young merchantable, above twelve inches D. B. H.
    - (d) Immature, below twelve inches D. B. H.
2. By ocular inspection arbitrary diameter limits were fixed for the three merchantable age classes, for instance:
    - (a) Veterans, twenty-six inches and over.
    - (b) Mature, nineteen to twenty-five inches inclusive.
    - (c) Young, twelve to eighteen inches inclusive.
3. From the tally of diameters and heights of actual stand, the total volume of a given tree class was computed for the plot.
4. The average merchantable height of the tree class was obtained from the same tally.
5. From the number of trees and total volume the volume of the average tree was determined.
6. From the average volume and average height the diameter of the average tree of the class was taken from the volume table, by interpolation if necessary.
7. The table of diameter on age, previously prepared (Table III), gives the age of a tree of this diameter, which is taken to be the average age of the tree class.
8. The volume of this tree class is the yield, based on the age of the class, for the forty. The total volume on the plot was thus divided into three yields, corresponding to the ages of the three tree classes.
9. The *area* occupied by each tree class was carefully determined for the forty, or plot, the method of doing this depending on the arrangement of the tree classes.
10. Given the yield and acreage of the plot, the yield and mean annual growth per acre were determined for each class.

The chief flaw in this method will be recognized at once, namely, that diameters of trees do not necessarily represent their ages, and diameter groups assumed to embrace trees of certain ages will in reality contain both older and younger trees, especially in the case of stunted trees. In forests where there is no correlation whatever between age and diameter this plan is not advocated. Nor is it necessary to use it in even-aged forests, whose age can be determined independent of size. But for forests of the longleaf type, the *average* age, obtained from a curve in which suppressed as well as dominant trees have been included, will, without any reasonable doubt, coincide with the diameter indicated by the growth curve, if the growth figures are taken for the same region and soil. On each plot, a separation into age classes may then be made on the basis of the diameters which will most closely coincide with apparent age classes in the stand.

The second weak point would seem to be the determination of the areas occupied by each age class. In practice this did not prove so difficult. Wherever the age classes grew in separate groups they could be mapped. When two or more classes were intermingled, measurements of crown space would indicate the proportion of the area occupied by each class. By depending on the arbitrary size limits, it was found that the labor of getting the areas of each age class was not greater than that involved in the other portions of the investigation.

The yields per acre were influenced considerably by the care with which this area determination was made. Two factors enter the problem—the area occupied by immature growth to the exclusion of old timber, and the areas entirely blank. The latter were distributed proportionately among the four age classes in order that the yields might be actual and not normal. But on most plots these blank areas did not exceed 10 per cent. and were usually less.

The young growth below twelve inches was found in the form characteristic of longleaf pine throughout its range. It occurred only in openings under full sunlight and was therefore grouped in larger or smaller patches, easily mapped. Only the area actually covered by thrifty seedlings, saplings, or poles was included in this type. Blackjack oak, or open spots not naturally included with old timber, were distributed among the four classes.

Although the sample plots were selected from the more mature stands and did not have as large a proportion of young growth as was found elsewhere, the distribution of age classes by area was found to be

Veteran.	Mature.	Young merchantable.	Immature.
16.5 per cent.	33.5 per cent.	25 per cent.	25 per cent.

In other words, fully one-fourth of the area of mature stands was occupied by trees below twelve inches and forming a future age class. In ordinary logging, most of this young timber is either destroyed or badly injured, with no thought of its possible value.

The rate of growth of the longleaf pine in this locality was measured on 200 trees, with results shown in the following table, which was based on age, but reversed for convenience in application:

TABLE III.

RATE OF GROWTH OF LONGLEAF PINE BASED ON AGE, TYLER CO., TEXAS

D. B. H.	Age.	D. B. H.	Age.	D. B. H.	Age.
1	11	11	71	21	188
2	16	12	80	22	203
3	21	13	90	23	217
4	26	14	100	24	231
5	31	15	111	25	244
6	37	16	123	26	260
7	42	17	136	27	275
8	49	18	148	28	292
9	57	19	162	20	310
10	63	20	175	30	328

The average diameter limits assigned by inspection as corresponding most closely to the age classes on the nine plots were:

Veteran.	Mature.	Young merchantable.
25.7 inches and over	18.4 to 25.7 inches	12 to 18.4 inches

The diameter of the average tree for each class obtained from average height, total number of trees, and total volume in class, was

Veteran.	Mature.	Young merchantable.
28.5 inches	20.6 inches	14.8 inches

The corresponding ages taken from the table are

Veteran.	Mature.	Young merchantable.
301 years	183 years	109 years

It is possible that the average age of the veterans is less than 300, since only the most rapidly growing trees ever survive to this age, and a curve based on 200 trees would tip upward at the upper end, due to dropping out of the smaller and less rapidly growing trees.

In actual application, each plot was worked out separately, and the sizes and ages chosen varied somewhat, thus giving a series of points for a curve indicating the yield per acre. From this curve, the yield of average stands was determined as shown in Table IV.

TABLE IV.

YIELD OF LONGLEAF PINE, BOARD FEET, DOYLE RULE, TYLER CO., TEXAS

Age.	Yield bd. ft.	Mean annual growth, ft.	Age.	Yield bd. ft.	Mean annual growth, ft.
100	8,600	86	220	15,400	70.2
110	9,500	86.3	230	15,600	67.8
120	10,300	85.8	240	15,800	65.8
130	11,000	84.6	250	16,000	64.
140	11,600	82.8	260	15,900	61.1
150	12,200	81.3	270	15,700	58.1
160	12,800	80.	280	15,400	55.
170	13,500	79.4	290	15,000	51.7
180	14,000	77.7	300	14,350	47.8
190	14,400	75.7	310	13,000	43.8
200	14,800	74.	320	12,400	38.7
210	15,100	71.9			

This is a somewhat remarkable result. Great uniformity was obtained in the figures from the different plots and by different students, and there can be no question that the figures shown actually represent the average production of the species in this locality.

The question remains: Are these yields capable of improvement under forest management, or do they fairly represent the capacity of the species? It will be noted that the mean annual growth is already at the maximum at 110 years and steadily falls, while the increase in actual quantity is very slow up to 250 years, when it, too, actually diminishes. At no time does the stand ever reach a maximum of over 16,000 feet per acre. This fact is in accord with actual conditions existing over most of the longleaf belt, the only exception being in regions where the tree has a better soil and more ground water available than usual.

Further light is thrown on this subject by Table V, showing the number of trees per acre at different ages. Here again, a close correspondence was obtained in the figures of different men and different plots.

TABLE V.

NUMBER OF TREES PER ACRE IN AVERAGE STANDS OF LONGLEAF PINE AT DIFFERENT AGES, TYLER CO., TEXAS

Age.	No. of trees per acre.	Age.	No. of trees per acre.	Age.	No. of trees per acre.
100	60	190	28	280	15.
110	55	200	26	290	14
120	50	210	24	300	13
130	46	220	22	310	12
140	42	230	20.5	320	11
150	38	240	19.0	330	10
160	35	250	18.	340	10
170	32	260	17.	350	9
180	30	270	16.		

This diminution of numbers so cuts into the yield that the net increase is very slight after 100 years. The influence of diminishing numbers on yield may be shown by computing the yield by the use of this table; obtaining the diameter of the average tree for the age given from Table III and the average merchantable height from a summary of the tallies of the plots, the volume of the average tree at each age is obtained; which multiplied by the number of trees per acre gives a close approximation to the probable yield per acre. (Table VI.)

No effort has been made to average these results by a curve, but the closeness with which this yield table coincides with Table IV is instructive.

We have, then, a condition which seems to indicate that longleaf pine does not increase appreciably in yield per acre after 120 years, the disappearance of trees through fire and decay offsetting the increase in size. These facts would be still more evident if deduction had been made for rot, which begins to appear at about 100 years, and amounts in old timber to 20 to 30 per cent. of the stand. The increasing value of the lumber in trees of larger size is sooner or later offset by decay.

TABLE VI.

YIELD PER ACRE OF LONGLEAF PINE, SHOWING EFFECT OF DIMINISHING NUMBER OF TREES PER ACRE, TYLER CO., TEXAS

Age.	No. of trees per acre.	Diameter, average tree.	Average merchantable height in 16-ft. logs.	Volume of average tree.	Yield per acre.
100	60	14.	3	130	7,800
110	55	14.9	3¼	165	9,075
120	50	15.7	3½	210	10,500
130	46	16.5	3½	240	11,040
140	42	17.3	3¾	295	12,390
150	38	18.1	3¾	325	12,350
160	35	18.9	3¾	372	13,020
170	32	19.6	3¾	413	13,216
180	30	20.4	4	491	14,730
190	28	21.1	4	537	15,036
200	26	21.8	4	586	15,236
210	24	22.5	4	635	15,240
220	22	23.2	4	688	15,136
230	20.5	23.9	4	751	15,395
240	19	24.6	4	811	15,404
250	18	25.3	4	873	15,714
260	17	26.0	4	940	15,980
270	16	26.7	4	1,010	16,160
280	15	27.3	4	1,073	16,105
290	14	27.9	4	1,139	15,946
300	13	28.5	4	1,205	15,665
310	12	29.	4	1,260	15,120
320	11	29.5	4	1,310	14,410
330.	10	29.9	4	1,360	13,600

If this condition is a natural one, we can assume these figures of yield to be very close to the normal production for the species. Several facts confirm this opinion. Fire always has and always will be an element in longleaf forests, and the problem is not how fire can be eliminated, but how it can be controlled so as, first, to secure reproduction; second, to prevent the accumulation of litter and reduce the danger of a really disastrous blaze.

But the factor which probably determines growth and yield is root competition for soil moisture. Longleaf stands are subject to severe droughts. The slow juvenile growth and long tap-root of the young tree indicate its adaptation to this condition. Very young stands of longleaf may be quite crowded and remain so for fifty to eighty years. But it was found that such stands, if closely crowded, fell off in growth so badly that there was a distinct loss of production. Trees under 100 years of age continued to grow vigorously in diameter even in rather dense groups, provided such groups were isolated and did not form a complete stand. But above this age it was found that groups of several trees standing close together would have differentiated themselves into dominant and suppressed trees, one or two trees with large crowns showing continued growth, while the rest were almost stationary. This occurred in groups surrounded by open space, and could not be accounted for by struggle for light. Root competition alone can account for the thinning out of mature longleaf forests and the wide spacing of veteran trees. It also accounts, to a greater extent than intolerance, for the absence of seedlings under the open crowns of veteran trees, and their appearance only in openings at some distance from such trees. The demands of the species for moisture, and the struggle of the individual to secure it in competition with other individuals, must increase tremendously with size and age.

The close similarity of the yields per acre obtained on these nine forty-acre plots in spite of the inclusion of all blank areas, and the uniformly low yield per acre of longleaf pine over its range, indicate that these figures are not far below normal. The indicated management for longleaf pine is to avoid crowding and not to attempt rotations much longer than 100 years or the production of large sizes. The habit of the species adapts it wonderfully to growth in open stands. Its sparse branching and the early death of the lower limbs, even when shaded only by those above, favors the production of a certain amount of clear length even in open grown trees. This is not true of the shortleaf or loblolly pines, which require crowding to prevent the formation of a spreading crown. The ideal form for young stands of longleaf would be to have them stocked at most with only about twice as many saplings as should be standing in the form of mature trees at the end of the rotation. There should be no necessity for the elimination of individuals by overcrowding. Under such conditions of stocking, where the saplings have plenty of light and root space, splendid growth is made on the driest soils. In fact, the growth of longleaf appears to be much more rapid on typical dry soils, when given proper space, than that of the occasional shortleaf saplings which sometimes find their way upon such soils.

The yield table is not complete nor very reliable between 80 and 120 years. An effort should be made to secure data on the possible average yield between these ages, since it is evident that this should constitute the future rotation on longleaf lands.

The rate of growth, density of stocking and yields for the same ages, are much lower for longleaf than for loblolly or shortleaf pines on soils capable of growing the latter species. But on longleaf land, the longleaf pine will in all probability produce as much material as the other species, if not more.

The management of longleaf lands is not the purpose of this article, but the ideal plan would be for the present owners to remove the stand in two cuttings separated by about twenty years, and afford fire protection. This would insure the starting of a second crop of seedlings. The States should then acquire such lands and hold them as forest reserves, since no private owner could afford to pay taxes for 75 to 100 years with no return. Therefore, private owners will not usually attempt more than the modification suggested, that is, removing the mature timber in two crops. Unless the young or immature timber is quite valuable and abundant, the second cut would be followed by an attempt to colonize the land, or its abandonment for taxes, of which the latter would be preferable if the State adopts the policy of holding such tax lands for forest reserves. Forestry in the longleaf pine belt will probably have to run the gauntlet of the land speculator and the deluded settler, just as it is doing in Michigan and Minnesota. If southern lumbermen and landowners would face this question honestly and plan now to devote their sandy longleaf lands permanently to forest production, taking the proper steps to maintain the land in a productive condition, untold waste would be avoided in the future both to states, communities, and individuals.

A NEW METHOD OF PLANTING

MORRIS KOZESNIK

(Translated from the German by S. T. Dana and E. H. Frothingham.)

Although planting has not yet been very generally resorted to in this country as a means of reforestation, it will undoubtedly play a prominent part in future forest management. It is now recognized that careless handling and hit-or-miss methods will result only in failure, and every effort is therefore being made to develop methods which may be depended upon to give satisfactory results. This translation from the German is published in the hope that it may aid in this work by making more generally known a method which has given excellent results in Europe. The article was first published in 1888, when it was awarded a gold medal at the International Scientific and Industrial Exposition at Brussels, and has recently been republished in a third revised and enlarged edition.—*The Translators.*

In artificial reforestation planting is ordinarily the principal method used. It is almost essential in establishing mixed stands, secures greater growth than sowing, and, when well done, gives better results in a relatively shorter time than does natural reforestation. The planting method which is now coming largely into use is the so-called "Hole-planting with help of the mattock," and the success of future plantations will depend to a large extent upon the conduct of this method.

This method differs from the Biermanns, Buttlar, and Mannteufel methods is that no uniform rule can be applied to it. For this reason, perhaps, it has gone through many changes which have seldom been to its advantage, and very diverse results are accordingly obtained in practice. When properly carried out, however, the method uniformly gives exceptionally good results and the seedling mortality incident to other methods is greatly diminished. A description of it should therefore be of much interest and value.

First of all, the method should be applied only to well-developed, thrifty plants, raised in nurseries. If seedlings are being handled, the spade should be inserted to an equal depth on both sides of the seed rows and about ten inches apart, so that the balls which are taken out may include the whole root system unharmed. The earth mass, not the plants, should then be grasped and struck two or three times against a smooth, soft, earth surface. It will then fall to pieces readily, if the earth is not too moist, leaving the root system free and entirely unhurt. Small transplants can be taken out with entire balls and freed from earth in the same way. Care should be taken to select a time for removing the plants when the proper degree of soil moisture is present, since the work goes on very quickly under such conditions.

Fig. I.

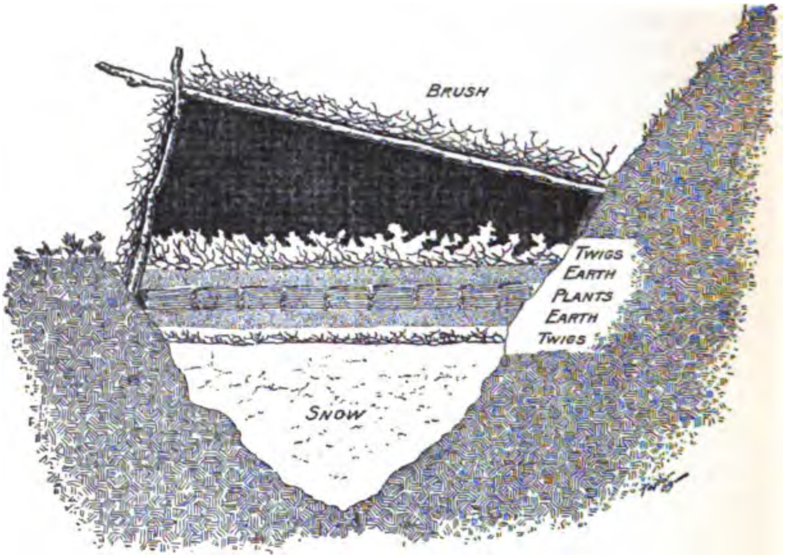


FIG. 1. Snow pit for storing plants.

The roots of the plants which have been freed from earth balls should at once be covered with fresh, but not wet, earth, and the plants then stored for later planting. An excellent device for storing young trees is the snow pit. (Fig 1.) Suitable places for snow pits are usually available in the area to be planted, such as the holes found after windfalls, but, when necessary, holes must be made. The pits should be about five feet deep and should be filled with snow, which is stamped down; on this comes a layer of fine branches or twigs, next a layer of fresh (but not wet) earth, and on this the plants, which should be covered with fresh earth and then some branches. Over the whole should be built a rude hut of branches, about five feet high. Plants kept cool in this way can be planted until about June 25. If planted later they would still grow very well, but would not lignify before frost.

In taking out of the nursery larger stock, such as saplings, both the spade and the mattock should be used, and the greatest care should be taken that in the main roots—best shortened with tree shears—as many as possible of the root fibers and their tips are preserved. Immediately after being taken out the roots of the plants (several in a bunch) should be covered with fresh (but not wet) moss, and the plants should be carried to the snow pit, placed on the floor of the fagot hut, and covered with some conifer branches. If they are likely to remain there long, some earth should also be thrown over the roots.

The actual field planting is carried out as follows:

(1) *With small plants:*

The planting hole is dug with the mattock somewhat deeper than the roots are long. The planter holds the plant with his left hand above the root collar and lowers it until it touches the bottom of the planting hole. Earth is then thrown in with the right hand, and at the same time the plant is raised with the left hand until the root collar reaches the level of the surface. This operation allows most of the roots to extend down vertically and the extreme root fibers remain deep in the earth.

Both hands are now simultaneously put into the earth about two inches from the stem, and the open hands are turned to the right and left in order to form a space on each side of the plant (Fig. 2). The closed fists are then placed in these two spaces (Fig. 3), and the earth pressed strongly horizontally on both sides at the same time toward the plant roots. During this horizontal pressure the plant, if still necessary, can easily be placed upright.

Fig. 2.

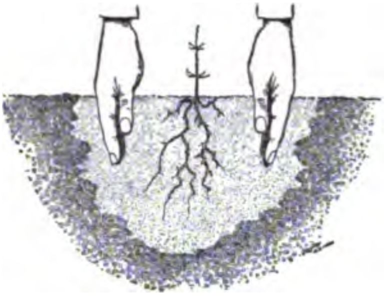


Fig. 3.

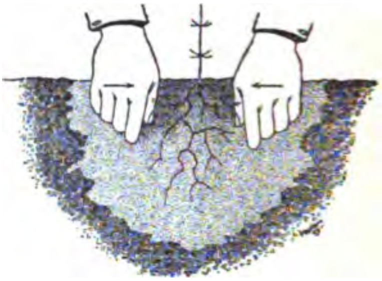


Fig. 4.

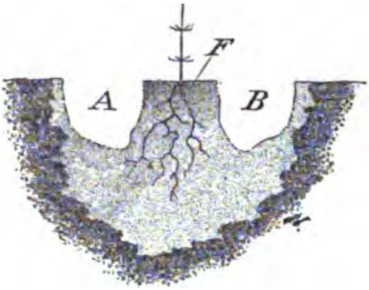
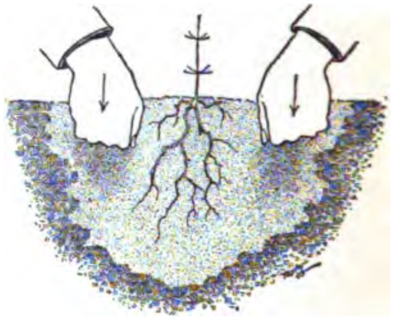


Fig. 5.



The plant now stands in the upright mass of earth marked F (Fig. 4), with the empty spaces A and B on each side. These are filled with earth, which is pressed firmly down vertically with closed fists (Fig. 5). The vertical pressure should not be applied *too near* the earth-mass F, in order that this may be pressed only laterally by the adjustment of the earth, and may not be pressed down along with it. This downward pressure leaves two small hollows, which should be filled up with loose earth. Loose earth should also be strewn about the plant in general.

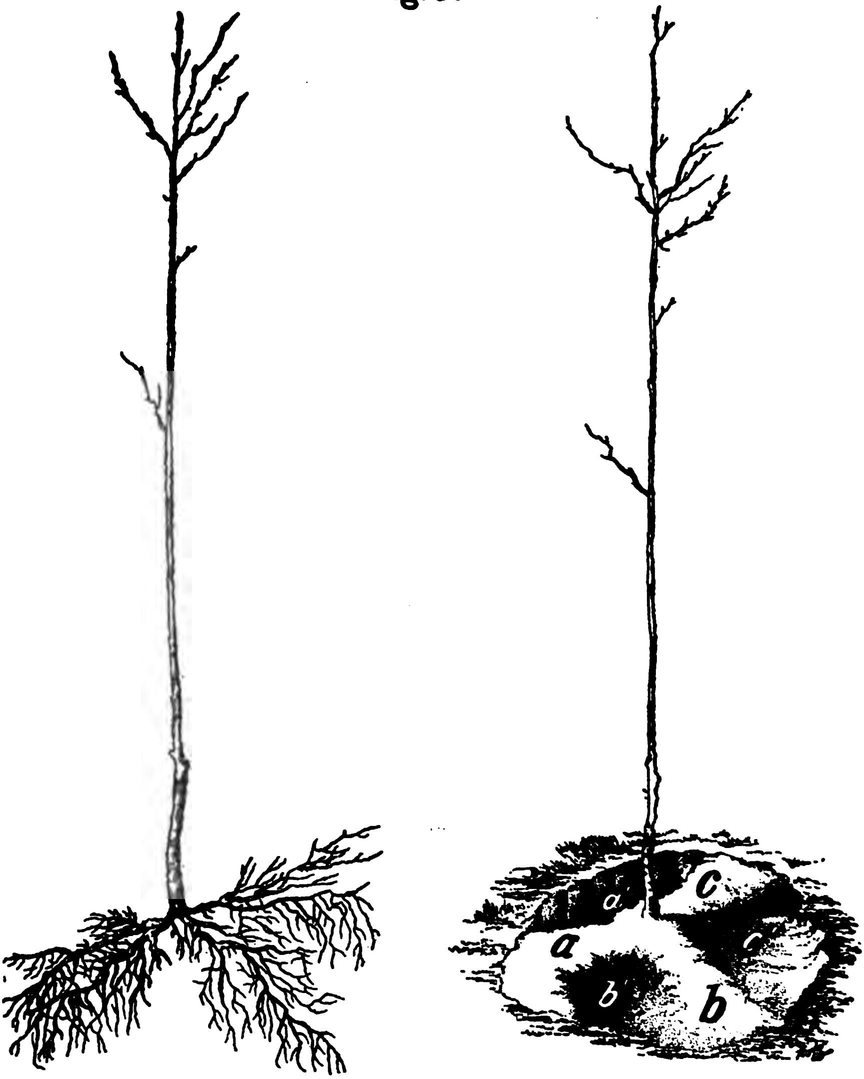
(2) *With saplings or larger trees:*

The planting hole should be made deep enough so that the long fibers can extend down vertically into it, and the earth removed should be heaped alongside the hole. Then the roots of the earth-free plant are let down to the bottom of the planting hole and, while about a third of the earth just taken out is thrown loosely over the root system, the plant is at the same time raised until the root collar has reached the level of the neighboring earth. This permits the fine root fibers to extend down vertically with their tips deep in the earth, while the larger horizontal roots retain their original position.

Each of the main root parts is now enveloped in a mound by scraping over it the earth in the planting hole. This forms several mounds, the number varying with the species, three in Fig. 6 (a, b, c), and three corresponding depressions (a^1, b^1, c^1). In the latter earth should be filled in and tramped down and the process repeated until the height of the mounds has been reached. The tramping down of the earth can be done wholly without care in a, b, and c, because no roots are present there. The vertical pressure nevertheless also exerts a lateral pressure on both sides, so that the earth in the mounds is made compact and the whole root system is enveloped in firm earth. Finally, the slight depressions which still remain should be filled up with loose earth.

The exercise of proper care in carrying out this method will require some pains at first. As soon, however, as the method becomes familiar to the workmen, the work will go along smoothly and more quickly than with the various other methods of hole-planting practiced.

Fig. 6.



The great advantage of this method is the attainment of a healthy and vigorous plantation. Even in the year of planting, the plants show a fresh green foliage with a vigorous leader, while even in dry years there is no loss, or practically none. This is because the root system is not only handled with great care, but, when planted, is enveloped in a firmly pressed soil, which permits capillary movement of water and at the same time hinders evaporation and encourages the formation of dew by the loosely spread earth on the surface.

As an example of the efficiency of this method may be cited a plantation on the estate of Grand Duke Carl Stefan in Saybusch, Galicia, made during the great drought of 1886. The plantation was made in the spring on a spur of the Carpathians, on a southeast slope with an elevation of about 2,300 feet. The soil contained humus, but was full of broken rocks. The species used were three-year-old spruce seedlings mixed with fir and beech transplants, with a few maple transplants. The beeches and maples were small saplings.

In 1886 Saybusch and the surrounding country had very little precipitation after the beginning of winter (January, 2.32 inches; February, 1.22; March, 1.13; April, 0.49); in general this year fell behind the fifteen-year average by 10.63 inches. In addition to this an abnormal heat occurred, which in May repeatedly reached 29 and 30 degrees Celsius in the shade.

The greater part of the area was planted in the first third of April; then came a period of over three weeks without rain. After the rapid disappearance of the snow which fell at the beginning of May, the planting was continued in spite of a bad drought, which continued for four weeks after the completion of the planting. The result was surprising, even to a firm believer in this method of planting. In midsummer a careful examination of the entire plantation did not reveal a single dead plant, and in spite of the great drought the plantation passed through the year without loss.

A second plantation made in the same locality and in the same year with the so-called "ball plants,"—plants with earth balls taken out by means of a semicircular spade—was not so successful, although the planting had been completed before the drought, and the area, with conditions otherwise similar, had the more favorable northeast slope. The continuous drought caused a severe drying up of the earth balls, the dew-precipitation could not enter these, and the result was a loss of 16 per cent.

These two plantations were made with equal care, and a part, at least, of the remarkable result obtained in the first case must be assigned to the method itself.

Excellent results have also been obtained in other plantations. With the single exception of the entirely abnormal drought of 1904, the mortality has only once reached as high as 3 per cent. (inclusive of injury by weevils), is often nothing, and usually averages only from 0.1 to 0.8 per cent.

William Freeman Fox

The Society of American Foresters has sustained a great loss in the death of Colonel William Freeman Fox, who died at Albany, June 16, 1909. Colonel Fox was born January 11, 1840, at Ballston Spa, N. Y. He was educated in Schenectady, N. Y., graduating from the Union Classical School and in 1860 from Union College. He served with distinction in the Civil War as a major and lieutenant colonel of the 107th New York Volunteers. For over twenty years he was associated with the forest interests of the State of New York and since 1893 held the position of Superintendent of State Forests. Colonel Fox was the author of many reports and articles dealing with forestry, among the more important being, "The Adirondack Spruce," 1894; "The History of the Lumber Industry in New York," 1902; "The Maple Sugar Industry," 1903; and "Tree Planting on Streets and Highways," 1903. He also was author of "Regimental Losses in the Civil War," 1889, and "New York at Gettysburg," 1900.

Colonel Fox was one of the pioneers of American forestry. He was an enthusiastic member of the American Forestry Association from the time of its establishment. His principal work, however, was in the State of New York, and to him is due the chief credit of a conservative state forest policy. More than anyone else he was responsible for the development of the largest state forest reserve in America and for protecting the State's interests under trying political conditions. The whole profession of forestry will mourn his loss.

Willard Weld Clarke

In a ranger's cabin while on an official trip through his forest, Supervisor W. W. Clarke, of the Cache National Forest, died on July 30, 1909. The family of foresters is still so young that when death strikes some of its members, it is of necessity from among those who are just entering into the period of greatest usefulness, when the plans and ideals of earlier life are beginning to mature. Such deaths are particularly sad.

Supervisor Clarke was born June 17, 1879, and received his earlier education in New York State. In 1902 he graduated from the New York State College of Forestry, being the first student who took the complete course of four years in forestry. While a student at Cornell, he was employed by the Bureau of Forestry during the summers of 1900 and 1901 as a student in field work in Arkansas, New York, and Tennessee. After graduating from Cornell in the spring of 1902, he accepted the position of forester in the Bureau of Forestry at Manila, P. I., where he remained for three years. In October, 1905, he was transferred from the Philippine Service to the United States Forest Service as a forest assistant.

While in the Forest Service, he was a forest supervisor, forest inspector, and, at the time of his death, again a supervisor on the Cache National Forest.

Clarke belonged to the type of men who leave their impress on life not by brilliant or voluminous contributions to science, but by results which come from common, daily tasks well done. He had a marked capacity for making friends wherever he went. His fairness to those who worked under him, his kindness and consideration for the mistakes of others while he was very severe to himself, his extreme devotion to his work, gained for him the respect and esteem of his associates. Although he had to earn his livelihood through college and to make his way in life, he did not become embittered and did not lose his cheerfulness and the disposition of a "big boy," as he was called by many.

The members of the Society of American Foresters feel very keenly not merely the loss of a most efficient forester, but in a personal sense, that loss which comes when a friend and fellow co-worker is taken away.

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